IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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Contributors and Contributions

General Education and Engineering

General education and its relation to engineering was the topic of an important session at the Spring Meeting. In addition to the paper by Prof. Dugald C. Jackson and Magnus W. Alexander, which was included in the June issue of MECHANICAL ENGINEERING, H. E. Miles graphically pictured the need for a greater understanding of the fundamental necessity of a broad educational basis for American civilization.

Mr. Miles, born in Wisconsin in 1860 and graduated from Lawrence College, has long been interested in this question of general education. As president of the Racine Wagon and Carriage Company he saw the need for continuation schools and was instrumental in the enactment of the Wisconsin continuation-school law, serving as president of the State Board of Vocational Education. Although retired from business, Mr. Miles was interested in educational problems during the war and at present is active in a committee on public education formed by a number of civic, business and industrial associations.

Harold C. Smith who told of the work being carried on by the National Metal Trades Association in the education and training of men in the industries of the Association, was born in Chicago in 1882 and graduated from Princeton in 1904. At present he is president of the Illinois Tool Works, of Chicago, and chairman of the Committee on Education of the National Metal Trades Association.

Automatic Hydroelectric Stations

At the Spring Meeting Power Session, Claude W. Place outlined the possible future power development of the Middle West. In his paper, an abstract of which appears in this issue of MECHANICAL ENGINEERING, he demonstrated the power potentialities of the innumerable small streams of that region. Mr. Place has been employed by the General Electric Company since his graduation from the University of California in 1901, except for two years' service in India. Since 1909 he has been stationed in the Mid-West field and at present is located at Chicago as engineer.

Machine-Shop Papers

The automobile industry has revolutionized life habits and manufacturing methods in this country. The far-reaching influence it has exerted on the machine-tool industry was clearly shown at the Machine Shop Session of the recent A.S.M.E. Spring Meeting by four papers. Frederick K. Hendrickson, who wrote on the general influence of the automobile on the machine-tool industry, has been associated with the Reed-Prentice Company for twenty-one years, and at the present time serves it in the capacity of engineer and designer. The influence of the automobile on gear cutting and gear-cutting machinery was discussed by Henry J. Eberhardt, who has been engaged in the manufacture of such machinery since 1904. Henry J. Hinde wrote on the relation of power presses to the automotive industry. Mr. Hinde, at present vice-president and general manager Toledo Machine and Tool Company, has been with this concern since 1888. Lathe practice as affected by the automobile was discussed by Ralph E. Flanders, who has had broad experience with the Brown & Sharpe Manufacturing Company, the Taft-Pierce Manufacturing Company, the International Paper Box Machine Company, the General Electric Company, the Fellows Gear Shaper Company and is at present manager of the Jones and Lamson Machine Company.

In addition to the papers relating to the automobile industry, Chester B. Lord outlined the fundamentals of interchangeable manufacture. Mr. Lord has had a diversified experience in the railroad and electric manufacturing fields. At the present time he is works manager of the Advance-Rumely Company.

Stokers and Mid-West Coals

The stoker problems involved in the utilization of bituminous and sub-bituminous coals of the Middle West were discussed at The American Society of Mechanical Engineers' Spring Meeting by John E. Wilson and Edward H. Tenney, whose papers appear in this issue of MECHANICAL ENGINEERING. John E. Wilson is at present traveling engineer for Swift and Company, supervising power and refrigerating plants. He served as Captain of Engineers in charge of refrigerating-plant construction for the A.E.F. Edward H. Tenney is chief engineer of power plants of the Union Electric Light and Power Company of St. Louis, and has been engaged in power-plant erection and testing and in experimental work for this company since 1905.

Accurate, Comprehensive Steam Tables Planned

The need for steam tables covering higher pressures and superheats and based on accurate physical determinations was emphasized by the discussion elicited on the presentation of Professor Heck's recent paper on Steam Formulas. Interest has been increased by the recent publication of the new tables of Professor Callendar. The latest development, described in this issue of MECHANICAL ENGINEERING, is the agreement by American authors and users of steam tables on a program of research upon which to base a more accurate and comprehensive set of data. Expressions of wholehearted coöperation and enthusiasm from all sides warrant a prophecy of ultimate success.

New A.S.M.E. Constitution In Part II

The broadening activities of The American Society of Mechanical Engineers require a new constitution. A committee of the Society has been at work on this for over a year and the results of its labor are published in Part Two of this issue of MECHANICAL ENGINEERING. It is desired to draw society-wide consideration to this document, which will be discussed at the 1921 Annual Meeting and presented to the membership by letter-ballot in the spring.

MECHANICAL ENGINEERING

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General Education and the Engineering Profession

By H. E. Miles,[1] New York, N. Y.

POSSIBLY no consequence of the Great War is more portentous than the decision of all the people of civilized nations that hereafter every man shall think for himself, and that no Prussian militarist or other group, however wise, shall think for the rest of society.

With this decision comes the requirement, not that we concern ourselves less with higher education, but more with the common schools and with new avenues of educational advancement, fitted to his circumstances, whereby the average man of whatever age, and the less favored, shall be trained to sound thinking upon social and economic subjects and for better accomplishment than heretofore.

Education is the development of the powers of mind and body, and public education, the taking of the money of all for the education of the children of all, is especially for the development of the social and economic understanding of all.

An idea of the present educational foundation of the American social structure may be gained from the chart of Fig. 1, which includes the total population of the United States under fifty years of age. The irregular line to the left of the chart may be called the death line as it indicates our diminishing population as life advances.

The inner curved line indicates the total school population, and the numbers in the first 6 grades, in the 7th and 8th, in high school, and in college.

It is commonly said that there is nothing of education in the first six grades where only the tools of education, the "Three R's," are acquired with which education is secured later if at all. As nearly half the children leave school at about 14 (in the mill towns of Massachusetts 70 per cent leave by the end of the 5th grade), it may be said that half leave school forever without any real education. There is, moreover, substantially nothing of formal education in "live civics" or in economics taught in the 7th and 8th grades. We may therefore say that education begins in this sense with the dotted line at the 16th year after 70 per cent of the children have left and therefore that our social structure with its great adult population in the large area *A* of the chart has an educational foundation in one corner only, that of the college and high school, rapidly diminishing from this little corner along the curved line from *C* to nothing before reaching *D*, with 43,000,000 wage earners and 20,000,000 of their wives and sisters of the same status in the area *A* who left school by the end of the 6th grade with never an hour of formal instruction in those things which make for understanding of our social institutions, of economics or the means of livelihood.

The inestimable value of this neglected 80 per cent of our citizenship is indicated by the careful testing of some 1,500,000 enlisted men in the recent war, showing that only one-tenth of the genius of our country is college bred, the other nine-tenths running all the way from high school to illiteracy, with 24.9 per cent of our people unable to read an English newspaper and write a letter home. We have been miners finding only one nugget in ten and missing the other nine.

Prof. Irving Fisher estimated, some years ago, the mere money value of the brain and muscle of our working people at $250,000,000,000 to $300,000,000,000, or five times the value of all other natural resources of the country combined. This equals in today's values and population not less than half a trillion dollars, an inconceivable sum. What a chance for engineering is this development of our human resources!

The following quotation from a chart hung on the bulletin board of a great high school, shows the insistence everywhere expressed that there is no chance for the American boy unless he goes to college:

DISTINGUISHED MEN OF AMERICA AND THEIR EDUCATION

With no schooling, of *5 million* only *31* attained distinction.
With elementary schooling, of *33 million* only *808* attained distinction.
With high-school education of *2 million*, *1245* attained distinction.
With college education, of *1 million*, *5768* attained distinction.

WHAT IS YOUR CHANCE?

With us it is "go to college or go to the devil" educationally. Rather, with reasonable encouragement of colleges, we should make equal provision for those who cannot go, by the setting up for wage earners and others in connection with their employment and otherwise, of the equivalent of high schools and colleges adapted to their circumstances, not unmindful of the findings above referred to, that only 30 per cent of our youth have the natural ability that will permit them to go through the present high school however much they try, and that presumably much less than half of this 30 per cent could by any chance go through college.

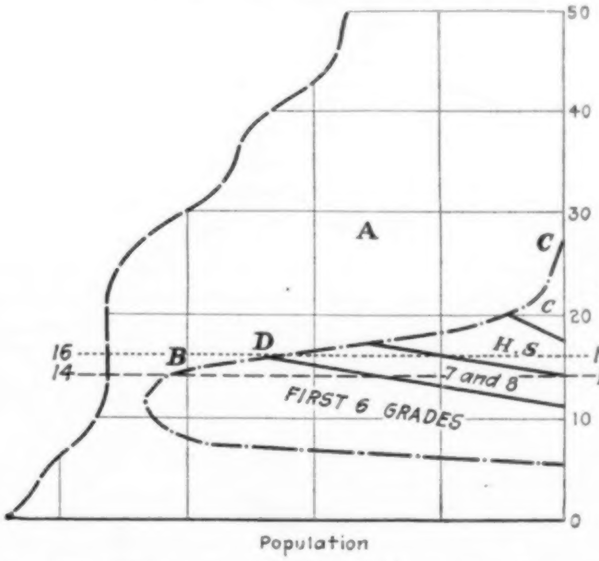

Fig. 1 Total Population and School Attendance, Russell Sage Foundation

Our Lack of Vocational Schools

Is it not an indictment of our intelligence that we provide no opportunities for the education in this wise of the 38,000,000 noted in the first two items of the chart just referred to? Several countries, with Germany leading, have shown the way. By a survey of 105 of Germany's greatest industries, 65 per cent of the men in foremost places in managerial and technical departments were little working boys who quit school at 14, grew up with the right sort of compulsory continuation schools, and later, selectively, enjoyed special technical training with the assistance of their employers and otherwise. Most of the graduates of her technical colleges served under these leaders from work schools and higher vocational schools, of which there are practically none in democratic America. This statement is not an endorsement of the German policy of

[1] Formerly President of Wisconsin State Board of Vocational Education.
Address delivered at the session on Training for the Industries, of the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers.

class distinction in education, nor of her terrible sin against her common people in withholding instruction in citizenship and inculcating instead blind obedience to authority. It is for us to give the best possible education to those who will not, and to those who should not, go into our present high schools so as to inculcate in them principles of good citizenship and of economic understanding. England prepared to do this recently in the Act of August 1918, the most comprehensive educational legislation ever enacted at one time by any nation.

As a major part of this program England is developing compul-

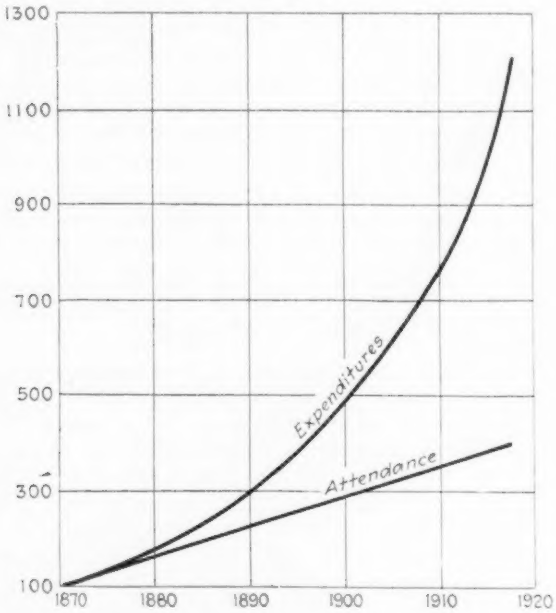

FIG. 2 SCHOOL ATTENDANCE AND EXPENDITURES

Trend of average daily attendance and expenditures in public schools in the U. S. from 1870 to 1918 in percentages of the figures of 1870—W. R. Burgess, Russell Sage Foundation.

sory continuation schools for all workers under 18, and similar schools for adults up to instruction of college grade for labor leaders and others. Educators commonly agree that this training can be given in the grades. Remarkable success is secured from informal, well-directed instruction in these subjects in our army training stations, noticeably at Camp Grant near Chicago with enlisted men, including the illiterates.

THE MOUNTING COST OF SCHOOL FACILITIES

Not satisfied with the results of public education, America is resorting to her old makeshift, increased money expenditures, as indicated in Fig. 2 which starts with 1870 as 100 per cent and shows the relative increase in expenditures to the increase in hours of school attendance in the succeeding decades. In 1880 the two lines are not far apart. For increased expenditures we got proportional returns. In the decade 1880–90 the line of expenditures rises more than twice as fast as that of attendance. In the next decade over four times faster. In the next decade, long before the war, seven or more times faster, while in 1914, still prewar, the expenditure line has gone into the clouds with little improvement in total schooling received. A few years ago we spent $400,000,000 for public schools; last year $750,000,000; this year about $1,000-000,000; and the retiring Federal Commissioner of Education says we should spend $3,400,000,000 all told, which I judge includes some quarter of a billion for colleges. And he has substantially no suggestion for a change in the old policy of "go to college, or go to the devil."

Having exhausted the means of increasing school funds by the present methods of taxation, our school people are seeking new methods, new state and federal appropriations, and new powers to school boards enabling them to levy taxes independently and without regard to other local needs. Must not industry and the citizenship at large seriously consider where additional income is to come from, and see how far present expenditures can be made to yield better returns? Let us try for economy and improvement and not for increased levies only. Let us remember that not over 30 per cent of American youth have the natural qualification that permit them to complete a high-school course; that the mortality in the high schools supports this finding, half or more dropping out at the end of the first and second years. Let us develop collateral facilities equivalent to high schools at a fraction of the per capita cost and more effective for certain types than the present high school which educators declare to be still in the experimental stage—to be cherished but supplemented and modified.

What is the solution? The following suggestions have been approved in their general features by all prominent educators to whom they have been submitted;

1 Elementary schools must be made more effective with the best possible instruction in citizenship and economics for every child before he leaves, and afterward in the continuation schools which have recently been established in 25 states, but very poorly developed. It is said that most of the instruction in the seventh and eighth grades is repetitional and waste, and can be replaced with citizenship and economics for those who go to work early, with a year saved to those who will study them in high school and college.

THE NEED FOR A LONGER SCHOOL YEAR

2 There must be more schooling per pupil per year. One-fourth of all enrolled pupils on the average are absent each school year, due to lax attendance and public indifference. Mr. Leonard Ayres says we have "the shortest school day, the shortest school week and the shortest school year of any first class nation in the world." See Fig. 3.

And what is all this for? For the child, who, as shown in the seventh bar, gets only an average of 605 hours of schooling per year, a year of 4500 waking hours, allowing ten hours for sleep. Remembering that 85 per cent of the chiidren in our cities do not go to the seashore or the country in vacation time, but stay in the

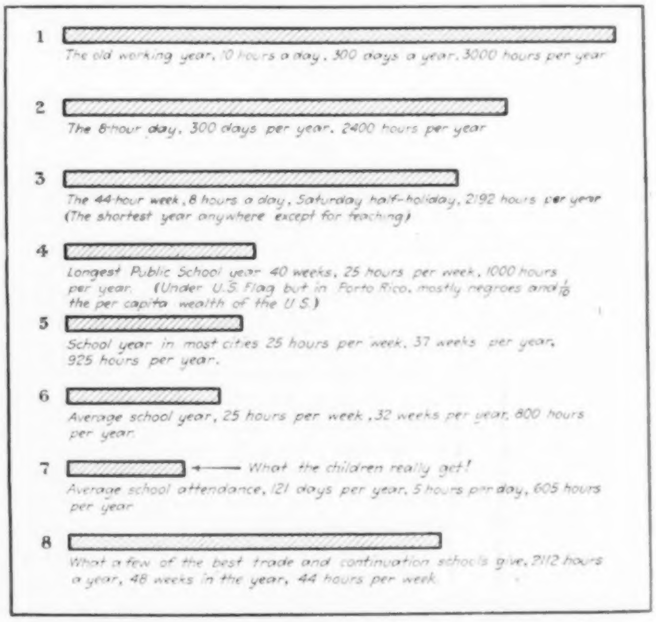

FIG. 3 WHAT IS A YEAR'S WORK FOR A HEALTHY ADULT?

Bars 5 and 6 show only the fixed school hours. In addition, many high-school teachers in good schools average about two preparatory hours daily. Little outside work is commonly done by elementary-grade teachers.

city streets, and that almost all leave school at 14 or 15 years of age with a sixth-grade education or worse, it is a sin of the first magnitude that they are not given all the education they can take rightly each day and year. With book learning they should have training in health, the use of leisure time and regulated play, to make them sturdy, masterful little citizens measurably ready for life's cares and opportunities.

With open minds the school authorities must find for themselves what hours in each situation a teacher should work and require no less. Some educators approve of Amarillo, Texas, which recently employed one-third less than her usual number of teachers and increased the school year to 46 weeks; with 50 per cent in-

crease in teachers' salaries, but no increase in the total salary budget. The Federal Commissioner of Education inclines toward a six- or seven-hour school day and a 46-week compulsory school year. Our long summer vacation is said to be a relic of agricultural days when all children helped to raise the crops.

3 Teachers' salaries must be carefully determined that they be commensurate with those paid in other comparable occupations, and that rating and promotion be dependent not upon period of service only, as now, but also upon personal and professional and qualifications. There is a spirit of rebellion on the part of many because merit counts for so little, and consequently there is less inclination than heretofore for superior people to enter the profession.

Results of Adult Education Shown in Increased Industrial Efficiency

4 Facilities for adult education must be immeasurably extended. Education must not stop with the 14th year, the 16th year or any other year. As in some other countries there must be provision in day and night and part-time schools, in factories and elsewhere, for every one of whatever age who desires to enlarge his understanding as a citizen or to improve his economic condition. The extent to which this can be done has been demonstrated and shown to be profitable to employers as well as workers. The chart of Fig. 4 was prepared by one of the best production experts in America and published by the Federal Department of Labor. It presents a cross-section of American industry. It is a composite of several charts, some by Mr. H. L. Gantt, and includes such different types of production as power tools in a great factory of international reputation and the making of brushes, all showing substantially the same condition.

It shows all these workers averaging only 46 per cent efficient, with 59 per cent of them 38 per cent efficient. Post-war charts are similar but the percentages somewhat better. The wonder is, as has been often disclosed, that many of the workers in the 59

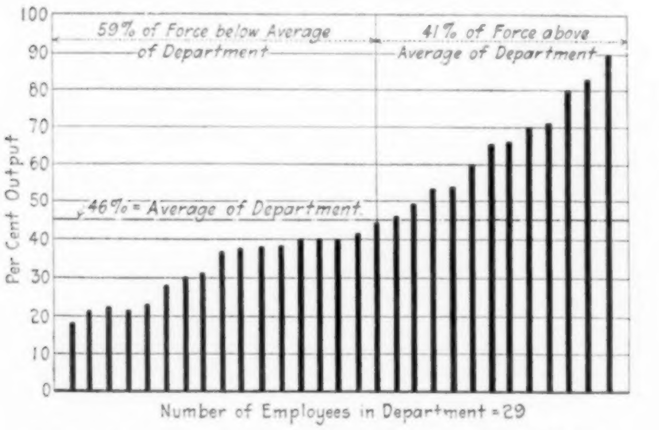

Fig. 4 Relative Efficiency of a Typical Factory Group

per cent group are as bright as the average in the 41 per cent of the best workers. They were put to work with no one to show them how. Those who, after proof in the best factories in America, have declared that the production of many workers can be doubled, have been criticized as exaggerating; but this chart shows how easy it may be to train an intelligent worker, man or woman, who is 38 per cent efficient, to be 75 per cent efficient. France by a general order required every considerable factory during the war to introduce these training departments; England also, but by clauses in her war contracts. If they increase production 20 per cent, which is easy, they effect a saving of $1,000,000,000 in payrolls, in wholesale prices of $2,000,000,000 and to the consumers $3,000,000,000. The aid to foreign trade with its keen competition is evident from this economy. But the greater accomplishment lies in the heightened intelligence, the happiness and the improved social attitude of the workers thus lifted in self-respect and capacity. What applies to factory workers in all these ways applies to all others.

The middle-aged man in a factory noted for its efficiency, whose production was increased 93.7 per cent by three weeks in the training department as shown in Fig. 5, looked upon his instructor as the best friend he ever had. He had been unable to support his family properly on his former earnings and considered himself a failure until so trained.

One of the largest producers of fine hardware in America tested the value of their training by the upgrading process in their special training room by comparing two men originally of equal capacity. The first man made no improvement in the 23 days of observation, while the other man doubled his production after 21 days of intensive instruction at absurdly little cost because the instructor was caring for other men at the same time.

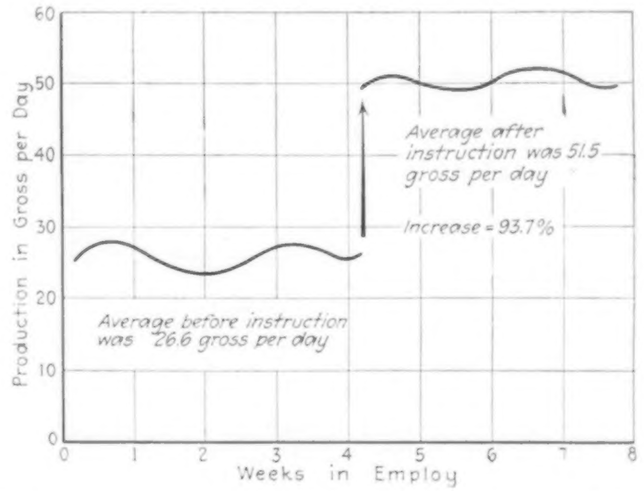

Fig. 5 Increasing Daily Production by Proper Training Methods

Fig. 6 shows how a group of 43 women long employed in one department increased their production 152 per cent in three weeks in the training department. In this case the training department was made a laboratory on methods, i.e., the methods of operation were improved at the same time as the skill of the operatives. As should always be the case, the teacher was a production expert who could also instruct effectively, giving him the twofold qualifications required in the trainer for production.

Fig. 7 shows, in the solid line, how a group of 50 women on power sewing machines were brought to full production in five weeks as against the 10 weeks (dotted line) required by old methods.

Apprenticeship Does Not Solve the Problem

We have greatly misunderstood apprenticeship in respect to its general applicability. It is desirable for the development of leaders who will cease to be wage earners as soon as trained. It is for one in a hundred. In three American factories famous for their highly developed apprenticeship courses it averages one in ninety. Most of our workers are doing work impossible of apprenticeship instruction of the old sort. The factory training department when rightly developed with what I call "intermittent apprenticeship" offers a substitute. A distinguished member of your association searches constantly throughout his force for average and superior men who want to advance, trains them for one limited field after another in his training departments and in regular shop work, and gradually lifts them higher and higher at good wages at almost negligible cost. He thus fills his best positions from the ranks, his master mechanic being of this class. The effect of this method upon the morale of the shop is evident.

To appreciate modern requirements and opportunities for trade training we must free our minds of traditional beliefs regarding apprenticeship. The so-called "halcyon days of apprenticeship" never were. There were halcyon days of guild monopoly with fathers paying large sums for their sons' indenture in these trades and their subsequent enjoyment of monopoly privileges, and there were apprenticeships of lesser value. I have diligently searched the authorities and, strange as it may seem, I cannot find that there ever was a time in England, the cradle of apprenticeship, when men entered apprenticeship much more readily than now because inspired by a desire to master a trade.

All through the middle ages from about 1261, the earliest mention of apprenticeship, to 1700, the time of its rapid decline, it was a

penal offense in England for any one except the eldest son of a master who "inherited apprenticeship," to buy or sell merchandise or to create any article embodying skill, except after apprenticeship which began anywhere from the eight to the seventeenth year, and ended about the twenty-fourth year. In about 1700, however, after two centuries of what we may call the "boot-legging" of those days, when men had persisted in acquiring skill in hidden places, in farm houses, "in aleys & upon steyers, and houses in corners," and in selling their products covertly, until finally the right to exercise one's faculties freely in production had come to be recognized, apprenticeship rapidly and greatly declined. Incidentally, it may be noted that during the long apprenticeship period of those days, little of mathematics or other book learning was taught and there was complaint as in our days that so far as the acquirement of skill was concerned the apprenticeship period might have been much shorter. It was made long that production might be cheaper.

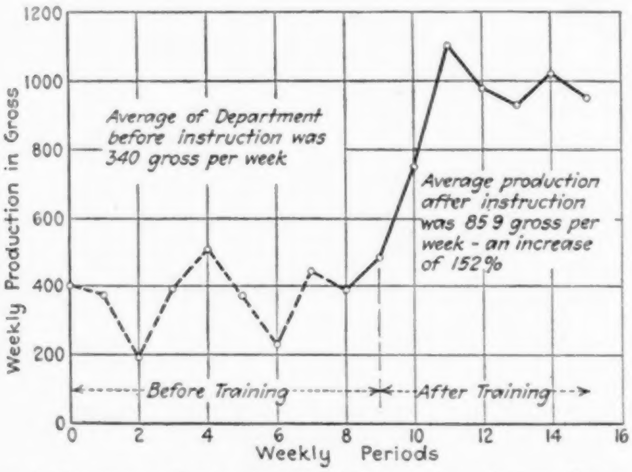

Fig. 6 Increasing Production of a Department by Correct Training Methods

During all these centuries England, by fixed policy and legislation, made low wages and this sort of apprenticeship the basis of her foreign trade and her commercial prosperity. She made herself supreme in skill and commerce, but her workmen paid the price.

It will comfort and inspire some of us to know that we need not attempt broadly and generally "to revive apprenticeship" by a return to the past, and that we have developed in considerable measure our own better way as shown in many factories, large and small.

Continuation Schools

The compulsory continuation schools now in operation in about 28 states are a modern substitute for the initial years of ancient apprenticeship. Where best developed, as in Boston and Milwaukee they are, with such extensions as will come naturally, the least expensive and most effective agency for the education of that 70 per cent of all our children who cannot or will not continue in the regular schools and have been entering the occupations at the rate of over 1,000,000 a year, unfitted therefor and without hope educationally.

Vocational education is essentially different from general education. The aim is vocation and education. The aim being different, the administration and methods must be different. Having, however, no system of vocational education in the United States we commonly think of it as something to be tacked on to the existing system.

Vocational schools, including continuation schools, must be directed and controlled by boards or committees representative of the vocations to be taught. Not because these representatives are better or worse than others; but because there are men in the vocations of as broad social vision and sound judgment as elsewhere, and because only men who have spent their lives successfully in the occupations know what the requirements are and can wisely select experts to meet these requirements.

The aim in vocational schools is production, the mastery of some one calling that leads ever upwards to higher places. Production is not merely the operation o' a machine and the making of things. It includes knowledge of the latest scientific methods as well as accuracy and speed. The Racine, Bridgeport and New Haven schools make commercial products for the market with the approval of labor leaders and all others. So do other good schools.

In Racine and Bridgeport the so-called "high-school manual training" is merged in the continuation and apprentice schools, thereby improving qualities, giving the favored high-school children desirable contact under superior conditions with their less fortunate fellows and saving the cost of separate high-school equipment and operation.

All-day vocational schools should operate 8 hours per day with Saturday half-holiday and 46 or 48 weeks per year, thus giving their working children, whose parents think they can ill afford to lose their children's time, the same hours they would have if in employment. This gives 10 per cent more hours of schooling in two years than the ordinary high school gives in four years, and gives a trade in addition.

5 Continuing the consideration of improvements, we may require, as a group of educators recently declared, that taxation be better safeguarded "to the end that a dollar's worth of education is received for every dollar spent."

The Training of Teachers

6 There must be great improvement in the quality and amount of teacher training in normal schools and in continuation and extension classes. Says the Commission on National Program of the National Education Association:

> The majority of the 600,000 teachers of the public schools represent in general a low level of maturity, general education and professional preparation.
>
> Of the twenty million boys and girls in our public schools today, it may be conservatively estimated that—
>
> 1,000,000 are being taught by teachers whose education has been limited to seven or eight years in the elementary schools;
>
> 7,000,000 are being taught by teachers who are scarcely more than boys and girls themselves;
>
> 10,000,000 are being taught by teachers who have had no special preparation for their work and whose general education is quite inadequate.

Support of Best Educational Leadership Essential

7 As a condition precedent to these attainments there must be an intelligent support of the best educational leadership, of which America has much that is as good as anywhere in the world. Also in the hundreds of thousands of devoted, aspiring members of the

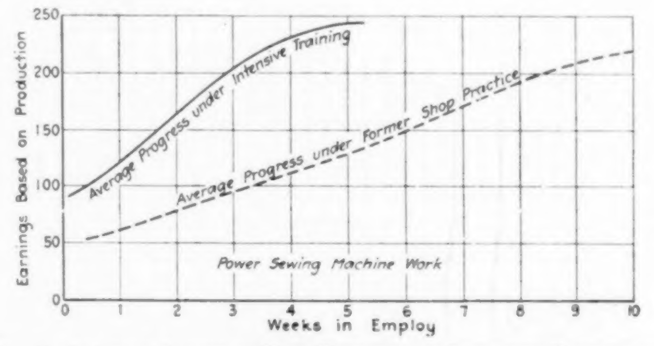

Fig. 7 Showing Saving in Time Effected by Intensive Training in Attaining Full Production

rank and file is a potential leadership hungry for opportunity.

Collateral to this support of professional leadership must be developed a lay leadership, not more devoted nor high-minded than most of the present leadership, but thoroughly informed and therefore courageous; not getting in the way of the professional; not, as frequently now and to as bad effect, unintelligently supporting the wrong type of professional leadership, selected from personal appearance, political or other pressure, on letters of recommendation the general value of which none know better than employers.

Public education is not alone a professional matter. Education must be linked with life continuously and the forces of society should unite with the professional forces of education for a joint accomplishment. To this end there should be a central agency or clearing house for the collection and dissemination of facts in the

(Continued on page 550)

The National Metal Trades Association and Industrial Education

An Outline of Its Activities in the Training of New Workers, with the Opinions of Its Committee on Industrial Education Regarding Apprenticeship, Trade and Continuation Schools, Instruction by Foremen, Training in Plant, and Vestibule Schools

By HAROLD C. SMITH,[1] CHICAGO, ILL.

REALIZING the need for national concerted action in handling labor problems with which they were constantly confronted, a small group of manufacturers engaged in the metal trades industry, in the spring of 1899, formed an organization for this purpose. After twenty-two years of steady growth this organization, the National Metal Trades Association, stands out preëminently for fair dealing, strength, and efficiency. Its primary object, as tersely stated in its constitution, is "to secure and preserve equitable conditions in the workshops of its members for the protection of both employer and employee."

The fact that our country has occupied for so many years a leading position as a world commercial power has been due in a large measure to its unrestricted productive facilities afforded by the maintenance of American principles. Realizing this, the organization adopted early in its career as a vital policy in dealings between its members and their employees, the open-shop, or American Plan, principle.

In addition to being a stanch advocate of the open-shop principle as the only sound basis in dealings between employer and employee, the Association has also been mindful of the necessity for, and the far-reaching benefits incident to, other constructive activities. Consequently its field has become widened from time to time until now it is a potent factor in the furtherance of industrial training, safety, sanitation, Americanization, and kindred subjects. It actively coöperates with other national organizations of a constructive character, and is affiliated with the National Industrial Conference Board, a federation of national associations of manufacturers in the principal branches of American industry, which it aided in organizing.

For a number of years the Association has endeavored to point out to its members the necessity for training in industry and the importance of their assuming an active part in this work by the establishment of training units in their own plants and by coöperating with both public and private institutions organized for this purpose, realizing that this question will have a far-reaching effect upon the future of our industries.

Clearly nothing will tend more to the stabilization of labor conditions than an adequate supply of competent workers, the need for which until a comparatively recent time has been most keenly felt, and a shortage of which exists even today for normal production. From the worker's point of view training offers an opportunity to increase his efficiency and thereby greatly enhance his earning capacity.

A Brief Survey of the Educational Work of the Association

One of the Association's early efforts in educational work was the equipping with machinery certain buildings in the Winona Technical Institute, of Indianapolis, and the furnishing of scholarships, worth $100 each, for prospective students, the contributions of equipment and scholarships being made by individual members of the Association to the Institute. Later the Association, in conjunction with the Indianapolis members, voted financial support to the Institute for the maintenance of a Metal Trades Department, and appointed a committee to coöperate with the officers of the Institution in the management of that department. Subsequently, when the school system of Indianapolis took over the Institute and started the present Arsenal Technical High Schools, the equipment was given to the "School City," from which nucleus its present extensive system of shops for vocational and technical education has grown.

In coöperation with the University of Cincinnati, under Prof. Herman Schneider, members of the National Metal Trades Association opened their shops in 1906 to the students in the University's "Coöperative Course in Engineering," with the result that young men there are now getting a practical and technical training which was impossible under the old order.

Realizing the spread of industrial and vocational education and appreciating the work of the National Association for the Promotion of Industrial Education, the National Metal Trades Association, at its annual convention in 1911, made an appropriation to be used at the discretion of its Administrative Council for advancing the work undertaken by the former. Similar contributions were again made in 1914 and 1915. The passage of the Smith-Hughes Bill, granting federal aid for vocational education, it is believed was largely due to the efforts of that organization, aided by individuals and associations.

Immediately upon its appointment in the summer of 1918, in order to meet the serious labor shortage created by the war, the Association's Committee on Industrial Education entered upon a plan which had as its object the breaking in of unskilled workers and increasing the efficiency of those already in industry. As the result of a conference with Mr. H. E. Miles, Chairman of the Section on Industrial Training for the War Emergency, Advisory Commission, Council of National Defense, Washington, D. C., it was decided to make a study of the so-called "vestibule schools," which had for their object practically the plan just outlined, i.e., the instructing of new help and upgrading those already in the plants.

Accordingly, the Committee began its activities by visiting Cincinnati and Dayton during the month of September 1918, and plans were made to inspect plants in the East that were operating similar schools. While the signing of the armistice seemed for the moment to have removed the urgent necessity for this particular kind of intensive training, it soon became evident that industry could not afford to ignore the continued need for industrial training in the competitive days of peace. The Committee was so strongly of this opinion that, following a tour of inspection of a number of plants in Worcester, New Haven, Bridgeport, Stamford and Buffalo, it unanimously recommended to the Executive Committee of the Association the employment of a man especially qualified to carry on this work, whose sole duty would be to visit each individual member of the Association for the purpose of making a study of the plant called upon and offering recommendations based upon such inspection. This recommendation was adopted by the Executive Committee, in July 1919, and after careful consideration, Mr. Philip C. Milter was selected for the position.

Various Plans Employed in the Training of Workers

As a result of its studies the Committee has found that the training of workers is now being carried on under five general plans, each of which has its place in industry; and the Association recommends each and all of them to its members, depending upon the special case under investigation. These five plans may be designated as follows:

1 Apprenticeship
2 Trade and Continuation Schools
3 Instruction by Foreman
4 Special Training in Plant
5 Vestibule Schools.

[1] Illinois Tool Works; Chairman of Committee on Industrial Education, National Metal Trades Association. Mem. Am.Soc.M.E.

Paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

Apprenticeship is particularly designed to take care of young men who wish to learn a trade in all of its branches, but is not generally adaptable to the instruction and upgrading of unskilled workers. The Committee feels that while there has been a lessening interest in apprenticeship as the result of conditions brought about by the war, this was nevertheless also due in a large measure to the unattractive conditions of the indentures. It hopes, therefore, to develop during the coming year some plan which it can recommend to the Association that will be sufficiently attractive to boys and the better grade of young men to hold them throughout the full course. Too much emphasis cannot be laid upon the desirability of each company's training apprentices in proportion to the needs of the industry, as regards growth and labor turnover.

Trade and Continuation Schools have for their object the manual and technical training of boys and young men in a particular craft or trade which they may select. By this form of education the boy is able to earn money throughout his school course, and if mechanically inclined obtain an education, whereas without such an opportunity many of them would be compelled to quit school entirely. This form of education is carried on in a number of cities, notably in Cincinnati, Ohio, and in Fitchburg, Mass. It has a further advantage in that it requires no additional expenditure or teaching force, with the exception of one supervisor to see that the industries and the public schools properly coöperate. Compulsory attendance at continuation schools by permit workers has also made rapid strides, twenty-five states now having legislation making education and training for these young people mandatory. The Committee recommends this form of education as being most desirable and most earnestly asks the interest of engineers and manufacturers in such schools where it is in existence, in order that they may be made most practicable and kept free from politics. There is a possible objection to the trade and continuation schools as the Committee sees it, and that is, they cannot be expected, no matter how efficient, to give to the minds of the workers that touch of confidence in the good intentions of a particular corporation in the same way that it can be given by the representatives of the plant itself, provided those who govern industry can be awakened to their duties.

This is the system most universally employed and it consists of putting the workmen directly into the department and under the supervision of the foreman in charge, who is entirely responsible for their success or failure.

The Committee found that the particular objection to this method was that the foreman, being responsible for the success of his department, in a great many instances had neither the time nor the patience to properly instruct the worker, nor in many cases the ability to impart his own knowledge.

There is also the possibility that prejudice on the part of the foreman may prevent him from properly instructing the worker in the performance of the required operations, the result being a lack of efficiency, causing a loss to both the employer and worker.

While the Committee admits that poor foremanship brings about many industrial faults, yet it does not believe that the foreman should be charged with conditions where the employers themselves have taken no definite steps to train him as to his particular duties. Foremen can be taught the fundamental principles of foremanship and department management from books and by teachers who are not themselves owners of industries, but, after all, the real policies that the foreman should live up to must be laid down for him by the manager of the plant in which he works.

Hitherto the foremen have had to build up their own policies from hearsay, deduction, or actual experience with each case as it came up. Different foremen translate management policies thus acquired in different ways, which means that the quality of foremanship varies from one department to another in a given plant. In the author's opinion, the only way a corporation can obtain a uniform dispensation of justice to its workers is for the management to see to it that its foremen are taught the policies of the corporation directly by the management or through authorized agents.

The proper course of instruction to the foreman should, in the opinion of the Committee, include:

1 The policies of the company as interpreted by its officers
2 The teaching of sound economic principles and their effect upon industry
3 The proper methods of manufacture
4 Proper instruction as to the best method to impart the above above knowledge to the workers under their supervision.

Special Training in Plant. This system, which consists of training in the department by a general instructor, has some of the advantages of the vestibule school and, it is believed, is preferable to instruction by foremen. It is particularly applicable in shops whose equipment consists mostly of large tools which cannot be isolated, and removes some of the objectionable features of training by foremen.

The Vestibule School. This plan came into prominence during the war. As the name implies, it is intended as the worker's entrance to the factory; and while by no means supplanting apprenticeship, is adaptable in some form to almost all shops, and, properly managed, goes far toward relieving the shortage of skilled labor. It has been applied very successfully to the intensive training of workers for repetition work, and has also been used to train specialists such as operators of particular types of machine tools. To this school should be sent all accepted applicants, where their fitness or unfitness is readily determined. The length of time spent in the school depends upon the skill possessed at the start, the aptness of the student, and the character of the work he is to be taught. The Committee found in the schools visited that the training time varied from three days to three months.

Since entering the service of the National Metal Trades Association, Mr. Molter has worked in eight districts, visited 130 shops, and has made a large number of formal surveys and a greater number of informal recommendations. His reports show that almost without exception the members visited have displayed much interest, and the Committee feels that worth-while work has been done. As a result of Mr. Molter's visits, a number of companies have installed definite training methods, while a greater number have signified their intention of doing so as soon as conditions warrant. In addition thereto it has been very gratifying to learn that a number of members, whose interest in industrial education has been stimulated by the publicity work carried on by the Association, have, of their own volition, set up complete training shops.

It is worthy of mention that the National Metal Trades Association is the only country-wide organization in the United States that is prepared to undertake the work of industrial training in a practical way, it being the opinion of its officers that the duty of furnishing industrial education to our young people will devolve sooner or later upon industry itself.

Among the reasons for believing that industry must assume much of the task of education is the fact that a great number of young people leave school at the earliest "permit age" in order to go to work. It is unnecessary to discuss the reasons for this phenomenon, but the facts as shown in the 1917 report of the Commissioner of Education show that out of a total school population between the ages of 10 and 14 of 9,939,532, only 145,891 or 1.47 per cent are not in school, while in the next group, ranging from 15 to 17 years of age and 5,823,160 in number, 2,463,458 or 42.30 per cent are not in school. The next group, ranging from 18 to 20, shows 82.87 per cent out, and of those from 21 to 24, 95.17 per cent no longer attend any sort of school.

Another table in this same report shows that the group which started school in the first grade in 1906 dropped from 4,066,091 at that time to 1,244,098 in the eighth grade, and of these only 629,432 entered high school in 1914–15, and it is estimated that only 117 out of each 1000 entering the first grade in 1906–07 would be graduated from the high school in 1918. Need we elaborate on this condition to show that we have a duty to perform?

Findings of Committee on Existing Industrial Conditions

As a result of its studies during the year, the Committee on Industrial Education of the National Metal Trades reported to the annual convention in April that they found the following conditions to exist:

1 A shortage of efficient workers for normal production
2 Too few companies train workers

(Continued on page 550)

Future Power Development in the Middle West

By C. W. PLACE,[1] CHICAGO, ILL.

In this paper the author outlines a system in which it is proposed that the fairly efficient steam power plants in the 100-odd cities of over 25,000 population in the 14 middle-western states be interconnected, not by heavy high-voltage lines, but by lines running from each which will pick up the small-town and village load to the point where its next larger neighbor will take its share; hydroelectric plants are to be installed on the streams near the towns and villages, each with a small pondage; the steam stations are to carry the steady continuous load above the maximum stream flow, the hydroelectric plants automatically coming on to carry the peaks. On the off-peak period the hydroelectric plants will restore the pondage and carry local load. The quickness with which the latter can get on the line (12 to 30 seconds) will enable the steam stations always to work at maximum efficiency. The advantages of the system are pointed out in the paper, as well as the procedure necessary to bring about its development.

UP TO a certain point in the growth of a country or under abnormal conditions, the growth and development are the important things: the means to the end or the cost are not of great consequence. Economy and the conservation of natural resources cannot be allowed to interfere with this early expansion, but there is nevertheless some stage of development and concentration of population where early methods must be changed.

Present Sources of Power in the Middle West

At present the sources of power for the supply of light, heat and energy for the mechanical operations necessary for the life and continued development of the Middle West are coal-, oil-, and gas-fired steam equipment, internal-combustion and heat engines, and water-driven equipment. Wind and solar-heat sources need not be considered.

Fig. 1 is a map of the Middle West showing the coal fields it draws from, as well as the rivers and larger streams. Table 1 gives the coal production of this region according to Government estimates for the period 1917–1920, and Table 2 data on the potential and developed water of the fourteen states it includes. Table 3 shows the oil production of the United States in 1920, that of the Middle West being 15 per cent of the total.

It will be noticed in Fig. 1 that the coal fields are not located conveniently as regards water supply for condensing purposes and are not particularly convenient to the load concentrations as at present arranged. A recent news report indicates that the Federal investigators on power conditions of the Atlantic Coast states have concluded that the solution of the problem does not lie in enormous production at the mines on account of condensing-water conditions. On the basis of our conditions and economical production, every 100,000 kw. produced in a day would probably require 380 million gallons of water, or a flow corresponding to 588 sec-ft., for condensing purposes. It would therefore seem that the demand for power in the Middle West cannot be taken care of at the mines as these are not situated near streams of the proper size. The rivers and streams are in better relation to the load, as the cities and towns have grown up along these streams.

Power Potentialities of the Rivers and Streams

The production of power thus far by steam has been practically always at the load concentration. A start has been made transmitting from steam stations to less heavy load centers. A moving of load to cheap power has been successful in a number of cases, but this has caused unnatural conditions in other respects and has not necessarily been for the greatest good of the country as a whole. We have no great sources of hydraulic power conveniently available which can be profitably developed at present money rates and material costs. We must therefore lay our plans on our real conditions and not on some imaginary combination as regards power supply or regrouping the load arrangement. Large blocks of power have been developed at centers of load by large steam stations. These large centers are, however, not close together but each has its tributary country with low load density. This territory is made up of towns and villages surrounded by farming country drained by innumerable streams.

Fig. 1 Map of the Middle West, Showing its Rivers and Larger Streams and the Location of its Coal Fields (Shaded Areas)

Most of these streams have comparatively low banks, have bottom lands which are good farming land and have extreme flood and low-water periods. As one travels along these streams any number of small dams may be seen that are either partly washed out or are still serving to drive some mill and making a more or less efficient use of the water going down the stream. From his observations the author would say that these streams would be

[1] General Electric Company.

Paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

able to supply the necessary power for all the towns and villages near them of 25,000 population or less; that during a good part of the year they could assist even in these towns during the peak if properly connected and manipulated. In these fourteen central states there are but 102 cities of over 25,000 people, and cities of this size have already established quite efficient steam plants.

Proposed Interconnected System of City Steam Plants and Village Hydroelectric Plants

Suppose now that the power houses of all these 102 cities were connected together, not by heavy high-voltage lines, but by lines running from each which would pick up the small-town and village load up to the point where its next large neighbor would take its share, and that the streams near these towns and villages had hydroelectric stations of a size proportionate to the size of their respective streams. These 102 steam stations must work on a fair load to get their best efficiency both from a steam-economy and a maintenance basis, and when the units are operating at good efficiency a sudden increase in load cannot be handled properly until other units are brought on and steam conditions have been restored. During this period of adjustment the voltage goes down and the frequency droops, and would droop more if the voltage were brought back to normal.

TABLE 1 GOVERNMENT ESTIMATE OF BITUMINOUS COAL PRODUCTION IN 1000 TONS

	1917	Per cent[1]	1918	Per cent	1919	Per cent	1920	Per cent
Total U. S.	551,790	100	579,385	100	458,063	100	556,563	100
Arkansas	2,143	1.0	2,227	1.0	1,680	1.0	2,310	1.0
Illinois	86,199	41.6	89,291	40.0	64,600	38.5	90,050	40.6
Indiana	26,539	12.8	30,678	13.7	20,500	12.2	30,420	13.7
Iowa	8,965	4.3	8,192	3.6	6,300	3.7	9,170	4.1
Kansas	7,185	3.5	7,562	3.4	5,750	3.4	6,700	3.0
Kentucky	27,807	13.5	31,612	14.2	28,500	17.0	31,000	14.0
Michigan	1,374	0.6	1,464	0.6	930	0.5	1,440	0.6
Minnesota	......	....	....	....	.....	....	....	....
Missouri	5,670	2.7	5,667	2.5	4,060	2.4	5,750	2.6
Nebraska	......	....	....	....	.....	....	....	....
N. Dakota	,790	0.4	,719	0.3	750	0.4	,770	0.3
Ohio	40,748	19.6	45,812	20.5	35,050	20.8	45,000	20.2
S. Dakota	......	....	....	....	.....	....	....	....
Wisconsin	......	....	....	....	.....	....	....	....
Total, 14 states	207,520	37.6	223,224	38.6	168,120	36.7	222,610	40.0

[1] Percentage opposite each state is percentage of production of the 14 states listed. 207,520,000 tons of 11500-B.t.u. coal will produce 249,000,000,000 kw-hr of energy at present efficiency, or at the rate of 28,000,000 kw. continuously. The total output of electrical energy in 1919 in U. S. was 3,215,552,000 kw-hr.

TABLE 2 WATER POWER IN THE MIDDLE WEST
(Extract from *Electrical World* Estimate, Jan. 1, 1920.)

State	Potential Maximum	—Developed— Hp.	Per cent of Max.	Undeveloped Maximum	Growth of Industrial Hp. req. in 1930 in Excess of Present Station Rating
Arkansas	75,000	13,400	17.9	61,600	7,000
Illinois	410,000	191,000	46.7	219,000	1,302,000
Indiana	140,000	123,000	130.0	....	558,000
Iowa	450,000	423,000	94.2	27,000	78,000
Kansas	320,000	105,000	32.8	215,000	7,000
Kentucky	250,000	61,400	24.6	188,600	62,000
Michigan	350,000	357,000	102.0	....	1,535,000
Minnesota	600,000	233,000	38.8	367,000	261,000
Missouri	200,000	39,500	19.8	160,500	49,000
Nebraska	280,000	65,200	23.3	214,800	....
N. Dakota	150,000	1,000	0.7	149,000	10,000
Ohio	215,000	200,000	93.0	15,000	1,150,000
S. Dakota	90,000	11,900	13.2	78,100	
Wisconsin	1,150,000	237,000	20.8	913,000	298,000
	4,680,000	2,121,400		2,608,600	5,317,000

Thirteen applications for Federal permits were made up to April 5, 1921, in the Middle West, and 205 applications in the entire United States and Alaska.

TABLE 3 GOVERNMENT ESTIMATE OF CRUDE-OIL PRODUCTION IN 1920

	1000 Bbl.	Per Cent Total of 14 States
Total United States	443,402	....
Arkansas	....	....
Illinois	10,772	16.2
Indiana	932	1.3
Iowa	....	....
Kansas	38,501	58.2
Kentucky	8,679	13.1
Michigan	....	....
Minnesota	....	....
Missouri	....	....
Nebraska	....	....
N. Dakota	....	....
Ohio	7,412	11.2
S. Dakota	....	....
Wisconsin	....	....
Total for 14 states	66,296	15.0

During 1920 about thirteen million barrels of crude oil were used by public utilities for power production. Of this California and Texas used 8,500,000 bbl. and Missouri and Kansas the greater share of the remainder. Crude oil is therefore of relatively little importance as regards the total power requirements.

Due to these conditions extra machines are now carried either under part load, or ready to put on at once. Suppose the interconnection mentioned above has now been made, and a goodly number of these hydraulic stations installed. These hydraulic stations are large enough to take a little more than the average stream flow, i.e., are overdeveloped. Each has a small pondage and is automatically controlled so that it will come on on a drop of frequency of the system and in sequence with other plants, depending on the proportion of its working head available at the instant. That is, the plant with the best water conditions will get on the line the quickest. It will drop off the line on a decrease of its water supply or a dropping off of load. The steam stations are operating efficiently and have a sudden increase in load.

These various hydraulic stations are operating, using up the natural stream flow and sending but a very small proportion of their load toward the city. With the droop in frequency the several water-wheel generators installed for the flow above the average begin to come in and to draw on the ponds. Enough come in to bring the frequency back to normal. In the meantime the steam stations are back to normal. The operators have not let the voltage stay down to save the speed, but have restored it at once and the service has been maintained. With this automatically started reserve there is an opportunity to decide whether the load is going to continue, and if so, to get on extra boilers and machines. It is known that the hydraulic helpers are going to begin to drop out as they exhaust their pondage, so the steam operation can be governed accordingly.

Again, suppose that each of these streams had the low swampy ground and the willow thickets made into ponds even where there was insufficient head for power development, which could release when the ponds with hydroelectric stations were drawn down by this sudden drain, and close when the station pond was restored. This would mean perfect flood control for normal rises, and, by holding out the steam stations, very good control during extreme floods.

These smaller streams lead to the larger rivers and with an approach at flood control on the tributaries there would be a greater number of locations for hydroelectric development on a larger scale along these larger rivers, each to be controlled in the same way. Each development would help the flood conditions below and make feasible developments not now economically practical.

Very closely resembling this hypothetical case is the arrangement for taking care of the peak load of New York City suggested by F. O. Blackwell at a meeting of the New York Section of the American Society of Civil Engineers, February 9, 1921. Mr. Blackwell stated that water if pumped up to an area on the Palisades during the peak, would develop the peak power more economically than it could be done by any other method of reserve. He further stated that this is being done in several installations in Switzerland, the water being pumped into reservoirs when the load is light. Prof. R. A. Fessenden in April published an article suggesting that such storage be made underground, the hole being dug near the load.

Our conditions do not perhaps lend themselves to this arrangement as readily as the combination mentioned previously. There are, however, cases where these schemes would probably work out. Along certain parts of the Mississippi River there are high bluffs and in some places the land is not particularly good on top of the bluff. A transmission line along the bluff might obtain the reserve capacity in this manner if at the same time the pondage could act as a reserve reservoir for city filter beds or some such purpose. There are high valleys in the Ozarks where there is no natural large water supply and where the land is of little value which could act as such a reserve if properly arranged and if in conjunction with the natural water-power supply in the same region. This might even make some of the powers with greatest water fluctuations economically feasible.

As regards Chicago, there is quite a large reserve at the east in Lake Michigan. On the way to Lockport there are large areas of worked-out stone pits and ground where it might be possible to get short-time storage so that the drainage canal could be upon for such peak service without unduly drawing down the lake level. Excess capacity would have to be installed at Lockport.

The State deep-waterway project could be overdeveloped and operate along this line if properly connected and operated.

All this sounds highly imaginary, but it is being done on a small scale in Saline and Seward Counties, Nebraska, along the Big Blue River, with manually operated and automatic stations, except that as yet there is no steam reserve. This system is being extended by the addition of more stations, and from present indications the entire river will soon have increasingly larger stations installed, the dam of each being at the point where the ordinary backwater from the dam farther down the river runs out. Other systems are also doing something along this line.

Advantages of the Proposed System

Suppose this idea were carried to its ultimate conclusion. The steam station would then carry the steady continuous load above the minimum stream flow, and the hydraulic equipment would carry the peaks, and on off-peak periods restore the pondage and carry local load. The quickness with which the hydraulic stations can get on the line (12 to 30 seconds) will allow the steam stations to work always at maximum efficiency.

All of these developments must be made at a cost that will show

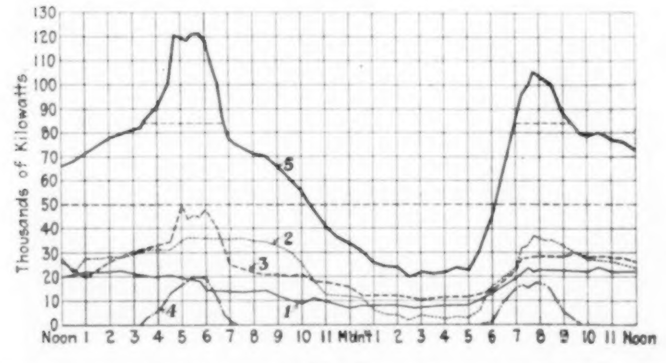

Fig. 2 Daily Load Curve of a City Having Steam and Water-Driven Power Supply for Lighting, Power and Railway Service

Curves	Kw. Peak	Kw-hr.	Load Factor, per cent
1—25-cycle steam generators..	24,000	362,150	62.8
2—60-cycle steam generators..	36,600	552,490	62.9
3—25-cycle hydroelectric generators............	50,000	528,000	44.0
4—Railway Co. steam generators	20,180	79,610	16.4
5—Total..................	121,500	1,522,250	52.5

a reasonable profit. In order to arrive at the correct profit, however, all the advantages must be weighed. A small automatic station tied to the line has a stabilizing effect on voltage which should be worth something. It should receive a credit equivalent to the transmission losses and another on the basis of the investment in coal storage of the steam station which it relieves; it should also receive some credit due to absence of labor trouble.

A multitude of these small stations will, by means of legitimate interconnections, do more actual work than the same installed capacity in one station. The small station made automatic can usually be installed on a much more satisfactory basis than the large plant. It can usually be financed locally, and a good share of the money will remain near the site. A large amount of land will not be taken out of production, so there will not be a large overhead, and the land taken will be of small value. If the development is forced beyond a certain point under middle-western conditions, this land becomes the most valuable corn land in that section, i.e., the second bottom land. The dam which before was an easy proposition on a more or less soft bottom, now becomes a difficult one, and the development will not show a profit. It is therefore necessary to multiply the number of stations instead of increasing the size if we wish to get total capacity. If these smaller stations are first installed it would seem that the larger streams could be used if developed on the same general plan and money made by the development.

Fig. 2 shows the daily load curve of a city having steam-and water-driven power supply, and having lighting, power and railway load served. If the water could be called to carry the sudden rise and the extreme of the peak it can be seen what an advantage it would be. It is evident that this could not be done with a single source of water power with any storage available in the river valley, but only with a number of such reserves acting for a territory rather than for one city.

What, now, are the things that we should do? In the opinion of the author—

1 The stream conditions and their possibilities should be studied with the above-described or some similar method of utilization in view.

2 Public opinion should be guided in the proper direction so that it will not obstruct such development.

3 Rivers which are technically navigable but are not really so should either be released or made navigable and the flow used for power development, and the engineer's influence should be used to bring this about.

4 In the permanent-highway-improvement campaign, influence should be used to have these permanent highways diverted from sites capable of future development or their natural ponds.

5 The relative importance of railway transportation and power development may change, so that any readjustments of railway roadbeds up river valleys should be along lines that will not interfere with the possible stream development. It may easily prove that the railway may be the first and most important benefactor in its electrification. Public sentiment might very easily assist in this.

6 Existing power sites in the form of mill dams should be developed and tied into the nearest transmission, and the possibilities in this direction should be investigated and taken advantage of in every locality.

7 The investing public should be instructed regarding developments in their vicinity. They should be shown that our water-power possibilities are not gold mines for the owners and are of little value if not tied in with existing systems; but that when they are so tied in they increase the value of the system and make its securities much better from the investment standpoint.

Germany Developing Water Power

Quite an extensive hydroelectric project is being undertaken in Germany in the development of the Neckar River. Capital requirements during the next few years are estimated at 950 million marks, while the total capital required for the completion of the scheme will amount to from 1900 to 2000 million marks.

While the ultimate object of the whole enterprise is the canalization of the Neckar and the linking of that river with the Danube, its immediate purpose should be seen in the harnessing of the Neckar and the generating of hydroelectric energy with a calculated output of 70,000 hp., equal to 300,000,000 to 400,000,000 kw-hr. The whole scheme represents a bold attempt to render large industrial districts in the south of Germany less dependent on outside coal supplies, and its success from a revenue-paying point of view will, in a measure, be linked with the future development of the South-German coal market and, above all, inland coal prices and coal taxes.

The entire project, covering the section of the Neckar from Mannheim to Plochingen—a distance of about 210 km.—provides for 25 to 28 dams. It is intended to start building operations at the five best-suited barrages without further loss of time and the first 700 million marks' worth of obligations will shortly be issued. Completion of the scheme in its present form will take from 10 to 13 years. Concessions have been granted for a period of 100 years.

Another big hydroelectric scheme is planned by the Prussian government in the form of a supplement to the state hydroelectric plants on the Weser and the Main, comprising four new plants to be erected on the Fulda at Cuxhaven, Freienhagen, Wahnhausen and Munden, of which only the Eder Valley power station is in operation as yet. Plants already erected and in course of construction on the Weser and Main will yield an aggregate of 66 million kilowatt-hours per year after completion, and the output of the projected Fulda plants is estimated at 69 million kilowatt-hours annually.—*Power*, July 26, 1921, p. 133.

Some Technical Problems in Aeronautics

Aluminum Cylinder Castings, Air-Cooled Airplane Engines, Airplane Carburetors and Radiators, Aerial Photography, Machine-Gun Synchronizers, etc., as Discussed on Occasion of A.S.M.E. and S.A.E. Joint Visit to McCook Field, May 21

In connection with the joint visit of the Aeronautic Division of The American Society of Mechanical Engineers and the Socety of Automotive Engineers to the Air Service Station at McCook Field, May 21, a very interesting technical program was presented by the members of the Field's staff. Joseph A. Steinmetz, Chairman of the A.S.M.E. Aeronautic Division presided. Brief summaries of the eight papers read immediately follow.

Aluminum Cylinder Castings

Discussing this subject, E. H. Dix stated that a satisfactory bond between the steel cylinder and the cast aluminum head was formed with either sherardized or tinned steel cylinders.

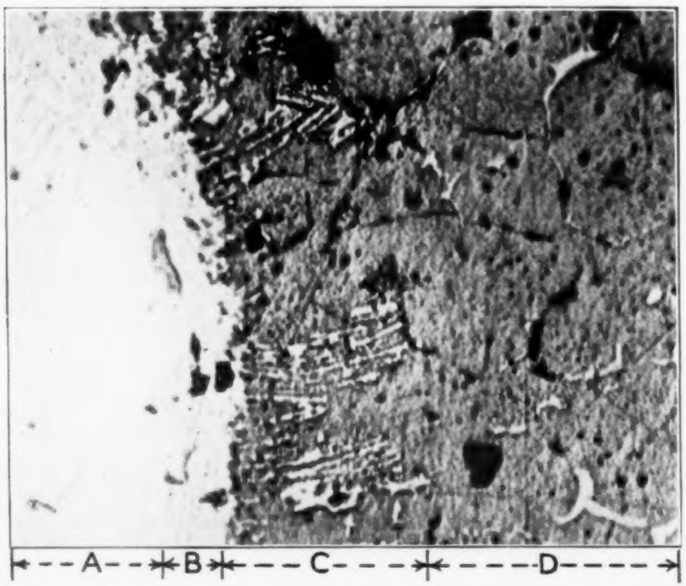

Fig. 1 Bond Between Aluminum Cap and Sherardized Steel Cylinder Unetched; Magnification × 200. A—Steel cylinder; B—Sherardized coating; C—Zinc-aluminum alloy; D—Copper-aluminum alloy.

Sherardizing was decided upon because of the higher melting point of zinc. A micrograph showing the bond is given in Fig. 1.

The problem of an alloy for valve-seat inserts and spark-plug bushings was solved by the adoption of a rolled phosphor bronze containing $3^1/_2$ per cent tin—chosen because its coefficient of expansion approximated that of aluminum.

The next step after these preliminary experiments was to make the actual casting. Fig. 2 shows the open mold with steel cylinder, cores, valve-seat inserts and spark-plug bushings in place. The job was made up using dry sand cores inside and outside. The method of gating is evident from the view of the cope. Three overflow risers were placed to allow for the pouring of metal through the mold.

Metal was poured through the mold so as to heat the cylinder and prevent the cracking of the aluminum casting if possible. However, the first casting showed a serious axial crack just over the steel ring. It was therefore decided to put a heating coil inside of the cylinder. This was done and a second casting poured. In this case, however, the cores were thoroughly heated before pouring, and the whole mold was placed in a core oven at 500 deg. fahr. immediately after pouring and allowed to anneal for a day and a half. This eliminated the cracking around the steel cylinder, but a crack developed in another place, that is, between two of the valve-seat inserts. It is believed that these difficulties can be overcome by slight changes in the method outlined, although preheating the mold and the subsequent annealing would make a rather expensive production job.

It has therefore been decided to endeavor to find an alloy which is less liable to crack than the one previously used which was 7 per cent copper, 1 per cent tin, and the remainder aluminum, this being recommended from the experience gained in England on a similar proposition. To guide in this selection, a hot-shortness test was devised. This consists in casting a test bar around steel lugs fixed 12 in. apart as shown in Fig. 3. The first three bars shown in this figure are aluminum alloys containing 8 per cent copper, 10 per cent copper, and 7 per cent copper + 1 per cent tin, respectively, and it will be seen that all cracked. The fourth bar is a silicon-aluminum alloy on which the Material Section is experimenting at this time. This bar showed no crack when cast in this manner. Arrangements are being made at the Bureau of Standards to have coefficient-of-expansion tests made on this alloy.

Mr. Dix pointed out that he had summarized very briefly a problem now of very vital interest to the Air Service and of which no more than the surface had been scratched, and he hoped by so doing an interest might be stimulated among the engineers present which would result in valuable suggestions for future work at the Field in this connection.

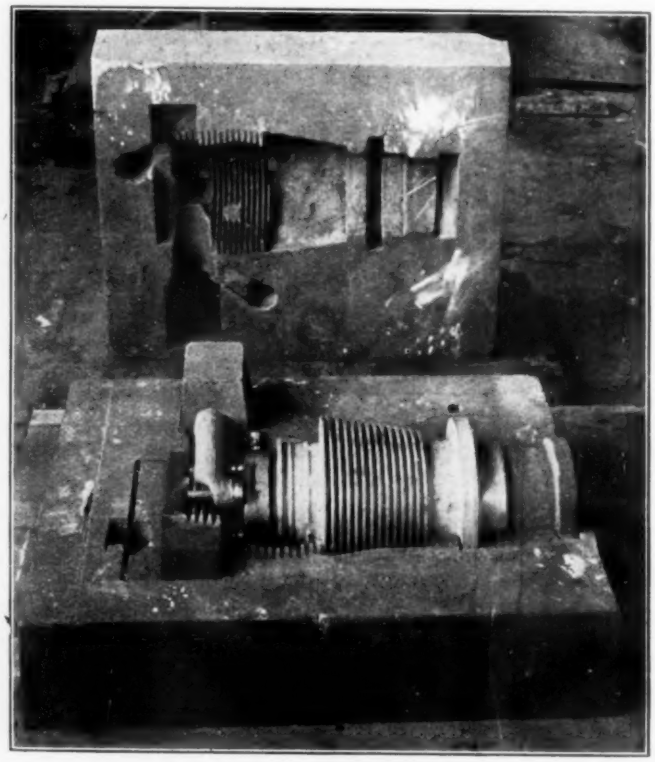

Fig. 2 Mold for Casting Aluminum Head on Steel Cylinder of Air-Cooled Airplane Engine. Dry Sand Cores Used Inside and Outside

Air-Cooled Airplane Engines

In his treatment of this subject, S. D. Heron pointed out that the advantages of an air-cooled engine for military purposes were that it is less vulnerable to fire, freezing does not occur during long drives, and overheating due to a steep climb is temporary. The air-cooled engine however, has not reached the finality of design of the best water-cooled engines, although cylinders up to

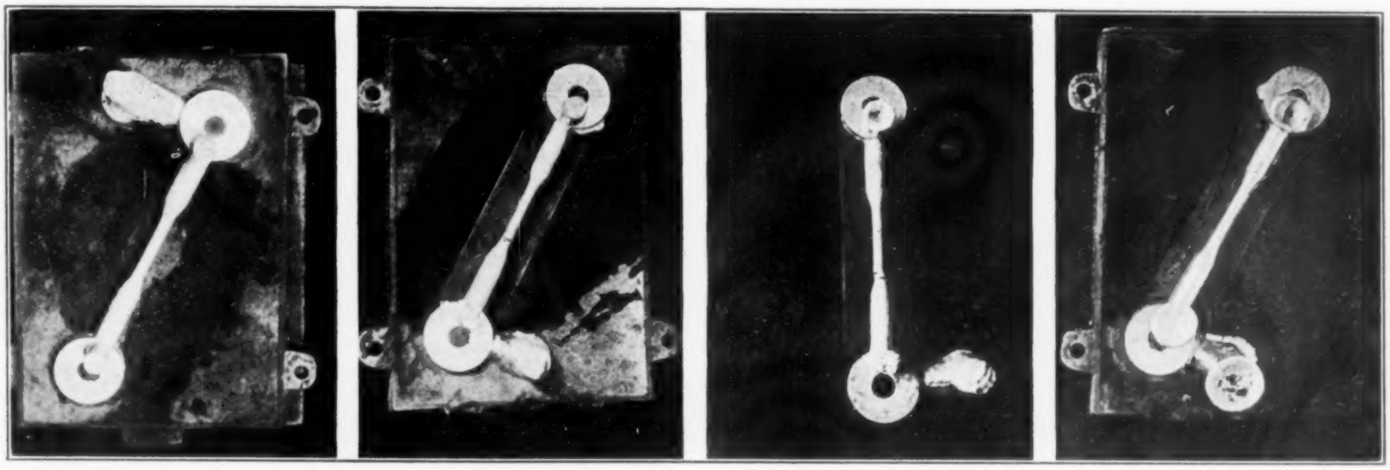

Fig. 3 Hot-Shortness Tests of Aluminum Alloys

150 cu. in. of swept volume have equaled the best water-cooled practice in power, brake mean effective pressure, and exhaust-valve reliability. Fuel economy with maximum power mixture is from 5 to 15 per cent less than in the best water-cooled engines. The advantages of the air-cooled engine have been shown in service when receiving a minimum of skilled attention. They have given good results in the Egyptian desert and in Mesopotamia.

In most designs of a cylinder for the radial engine, a compromise between cooling efficiency and proper valve operation is evident. The speaker pointed out that in the air-cooled cylinder cheapness and lightness have been overemphasized, with the result that cooling features have suffered. The resulting designs would not be tolerated in a high-class water-cooled motor.

Fig. 4 Probably the Largest and Most Powerful Air-Cooled Airplane Cylinder Yet Made (8 in. Bore by 10 in. Stroke)
(Cylinder at the right is $4\frac{1}{2}$ in. by 6 in.)

As to V-engines, twelve-cylinder types up to 240 hp. have been constructed satisfactorily and have given good service. The valve operation of this type is complicated because of the location of the exhaust side of the cylinder relative to the air blast.

Dealing with the question of cylinder design, Mr. Heron described the results secured by the British with the spherical aluminum head cast or screwed to an integral fined steel barrel. He presented data from a number of tests of air-cooled engine cylinders which show that the highly efficient cylinder has not a low weight per cubic inch of swept volume. Fig. 4 shows probably the largest and most powerful air-cooled cylinder yet made—the R.A.E. 19 T., with 8 in. bore and 10 in. stroke and developing 129 b.hp. The cylinder on the right is a $4^1/_2$- by 6-in. R.A.E. 22 T.W.

Carburetors for Aircraft

THE carburetor problems of aircraft engines were outlined by C. Fayette Taylor in his remarks. A more simple type of carburetor can be utilized in airplanes than in automobiles, the open-tube type with some form of accelerating well being the most common. Most aircraft engines carry from two to six carburetors, which constitutes a problem in obtaining uniform adjustment and synchronization. This precludes the ordinary needle-valve fuel adjustment, and fixed fuel orifices are therefore the rule. The necessity for operating under extreme variations of temperature and pressure requires that the fuel-metering orifices must be large enough to take care of the highest density at which the engine will operate. A manual control is therefore provided.

Fig. 5 Airplane Models, Showing Systems of Camouflage for Upper Surfaces. Dark Areas are Models Covered with Standard Varnish

Extreme variation from the horizontal position brings about a severe condition for the aircraft carburetor. This condition is met by carefully locating the float chamber in relation to the fuel nozzles amd metering orifices.

In order to reduce the fire hazard, the carburetor air intake must project outside the engine cowling. This means that the aircraft carburetor must take its air from a slip stream traveling from 100 to 200 m.p.h.

Airplane Camouflage

THE purpose of color camouflage for airplanes as stated by Gerald P. Young, is to break up the outline of the plane. The coloring of the upper surfaces is a combination of tan, blue green and mauve purple. The general scheme followed is to divide the surface into three irregular areas of large curving boundaries, applying these three colors both to the upper surface of the top wing and the upper surface of the lower wing. The same colors are brought back along the top of the fuselage and tail surfaces. The idea is to make the plane less visible when observed from above, and a tan section, blending with tan earth colors, causes it to become practically invisible, leaving only the darker colors which, being arranged irregularly, throw the eye off from the general outline of the plane and cause the observer to lose the plane in the background beneath.

This system is of value for planes left in the open at flying fields or when parked in the field at night, and also for concealing bombers flying at low altitudes and observed by pursuit planes from above.

The under surfaces of planes are camouflaged to give a light reflecting surface and the coloring scheme is burnished aluminum, light blue, light purple and white. This system makes it possible for an airplane regularly finished in dope and varnish having a light yellowish cast and visible at altitudes up to 17,000 ft., to become invisible at an altitude considerably under 10,000 ft.

Radio Communication

DEALING with this subject, O. E. Marvel described the characteristics of continuous wave transmission and the vacuum tube, the one thing that made the radio telephone possible. He explained that all airplanes radio sets are now designed for telephoning and continuous wave telegraphy. He emphasized the importance of radio communication, especially in military movements such as artillery fire control, infantry contact work and reconnoissance. He also emphasized the importance of wireless in direction finding—used during the war to locate enemy radio stations and to navigate aircraft.

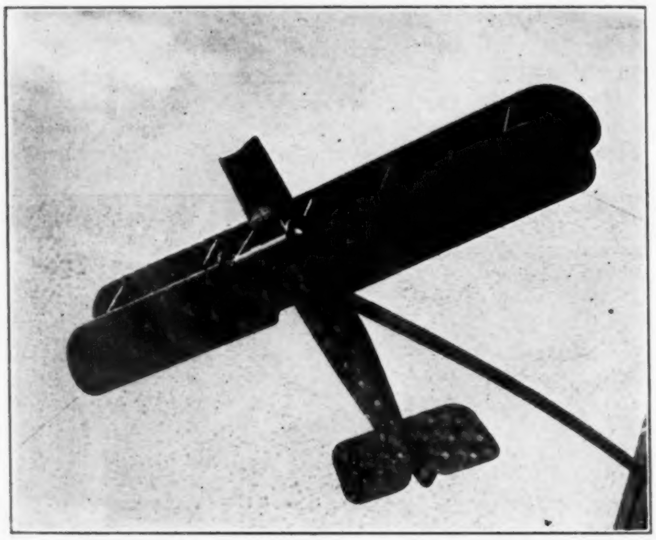

Fig. 6 Airplane Model Against Sky Background, Showing Comparison of Standard Varnish with Camouflage Scheme

Airplane Radiators

LIEUT. Bayard Johnson spoke on the subject of airplane radiators. He pointed out the fundamental differences between the problems of radiators on an airplane and on an automobile engine, emphasizing the large quantity of water which must be forced through the airplane radiator and the need for unrestricted flow. The standard radiator core adopted by the Air Service is made of seamless round copper tubes with hexagonal ends. It gives small resistance to water flow, has no internal soldered joints, can be easily installed, is light and is most effective for air speeds of 80 miles per hour and over. In discussing the location of a radiator he emphasized the necessity for a support as free from vibration as possible. Comparing relative values of frontal, wing, landing-gear and side radiators, the advantages of the side radiator were shown, as they are protected from damage and have high air speeds available. Although the piping is long, it is accessible and warms the pilot bands. He also emphasized the need for accurate information as to the performance of different types of radiators and stated that the Engineering Division of the Air Service was progressing favorably in obtaining this information.

Aerial Photography

IN discussing aerial photography, Capt. G. W. Stevens described different types of films and plates and showed that film in rolls permitting 100 exposures, which does not require bulky, heavy magazines and is not subject to chipping or breakage, is more desirable for aerial photography. With suitable ray filters to eliminate haze it is possible to get good negatives from heights of three to four miles. A camera specially designed by Major Bagley of the Corps of Engineers has three lenses, making one vertical and two oblique negatives at the same time. At an elevation of 15,000 ft. it takes in an area 8 miles wide. With this mechanism artillery fire control can be carried into the enemy country with an error of but 200 ft. in 15 miles. The use of the camera in mapping was explained by the speaker, who showed a slide of a mosaic of the city of Rochester made up of 83 negatives.

Fig. 7 Oblique View of Washington from 4007 Feet, Taken by the Air Service

Fig. 8 New York Skyline from 1000 Feet, Taken by the Air Service

(Continued on page 562)

The Influence Exerted by the Automobile on the Machine-Tool Industry[1]

A Group of Papers Dealing with the Changes Brought About by the Automobile in Machine-Tool Design, Construction and Operation, Together with a Discussion of the Fundamentals of Interchangeable Manufacture

THE session of the Spring Meeting of The American Society of Mechanical Engineers held under the auspices of its Machine Shop Practice Division was devoted to a consideration of the influence of the automobile on machine-tool design and operation during the past decade, with special reference to gear cutting, lathe practice, and the stamping and forming of sheet metals; and to the subject of interchangeable manufacture. Five papers in all were presented, abstracts of which follow, together with a brief account of the ensuing discussion.

THE INFLUENCE OF THE AUTOMOBILE ON THE MACHINE-TOOL INDUSTRY IN GENERAL

By F. K. Hendrickson,[2] Worcester, Mass.

DURING the years 1910 to 1913 the automobile industry began to exert a great deal of pressure on machine-tool manufacture and design, and about this time several concerns found it necessary to make extensive and very expensive changes in their systems of production to meet the rapidly increasing demand for cars. To arrive at the best conclusions and in order to secure the most modern installations, they invited many of the best engineers and machine-tool manufacturers in the country into conference with them. Each individual piece was considered separately and at times in the presence of two or more representatives from different firms, with the result that highly specialized machines were rapidly developed.

A brief study of the developments in machine-tool building attributable to the demands of the automotive industry therefore seems desirable at this time, taking up in their order the following elements which go to make a successful machine:

1. Materials and their proper distribution
2. Precision and Specialization
3. Power
4. Manipulation
5. Speed
6. Lubrication
7. Safety Devices.

Materials. Every mechanic is fully aware of the extremely rigid construction which has been demanded, due to the ever-increasing strains to which machines are subjected. In addition to the extra weight thus entailed, materials of high tensile and torsional capacity have been substituted. A few examples will suffice to indicate the trend.

Lathe spindles originally 30- to 40-point carbon steel, are now made of 15- to 20-point steel, being carbonized and hardened to produce glass-hard surfaces. The diameters also have been greatly increased.

Lathe centers formerly quite small, unhardened and of low-grade tool steel, are considerably increased in size and hardened at the point on both head and tail stocks.

High-speed cutting tools generally supported in special rigid holders are replacing almost entirely carbon-steel lathe and planer tools, twist drills, reamers, milling cutters, taps and dies.

Babbitted journals or bearings are rapidly being replaced by the best-quality bronze metals, and the tendency is toward the application of ball bearings. Certain types of machines have already been forced to incorporate them on their main spindles and with success, which indicates that the same conditions will ultimately obtain in other machines.

Cast-iron gears for speed and feed changes have been discarded in favor of the hardened steel gears, except in a few machines where the speed changes are accomplished by the engagement of friction clutches, thereby permitting the gears themselves to remain constantly in mesh their full depth and width of tooth, and leiminating the shock that otherwise results.

Clash gears, either of the sliding or tumbler type, have proved absolute failures when made of cast iron or soft steel, but are satisfactory when made of the proper steel and subjected to suitable heat treatment.

In addition to producing gears of wear-resisting qualities, it has also been necessary to develop their efficiency and to produce much quieter running. To accomplish these conditions, several machines are today equipped with helical or herringbone gears to produce smooth action and silent running under high speed and strain. New forms of spur gears are also being developed which are claimed to successfully meet the requirements.

Precision and Specialization. Grinding machines have been brought to a high state of perfection and produce a truer and finer quality of work on all revolving and sliding parts much more rapidly than ever before. Closer limits and tolerances have been demanded, with the result that the one-time all-around mechanic has been replaced by the present specialized expert, in order to obtain the highest grade of precision in quantity.

Power. Along with the added strength and rigidity of the machines must necessarily be considered their power. The automotive industry has accomplished much in the direction of insisting that the drive shall be either of the geared or silent-chain type to prevent slippage, usually prevalent when machines are belt-driven. The individual motor installation has also come into common use, and at the same time the horsepower of the motor has been increased sufficiently to care for the extreme loads.

For example, a few years ago a 14-in. geared-head lathe was equipped with a $^3/_4$-hp. motor, while today the machine must be provided with a motor of 2 hp. at least and preferably 3 hp. This proportion may not be general for all classes of machines, but is a fair criterion of the present condition.

Manipulation. One of the very essential features demanded in present-day machines by the automotive industry is easy manipulation and the convenient location of the operating levers, handwheels and cranks. Speed- and feed-changing mechanisms must be located within easy reach of the operator and must not cause him any undue exertion or unnecessary delay.

Where there is a sufficient quantity of pieces and the parts lend themselves to magazine or hopper feed, these must be included in order to assist in the handling of work. If the parts are heavy or bulky, mechanical or electrical handling devices must be provided in order to secure high production.

Speed. Several years ago speed bosses were practically unknown, but with the advent of the automobile era has come this type of functional foreman and with him a demand for readily obtaining in a given machine the proper speed and feed for the work. To meet this ever-increasing demand machine-tool manufacturers have in general incorporated mechanical speed-change heads and quick-change gear boxes for feed variations in their machines. Motors of the variable-speed type are used when mechanical changes are not available.

It is interesting however, to note certain specific conditions which, although contrary to the general demands, have worked out in the most gratifying manner. During 1912 and 1913, in a well-established automobile plant in Detroit, the production of

[1] Abstracts of papers presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

[2] Chief Engineer and Designer, Reed-Prentice Co., Mem. Am.Soc.M.E.

transmission parts was receiving the most careful consideration as to the best method to adopt to materially increase their already heavy production. It was finally decided to adopt a single-purpose lathe having one speed and one feed, properly calculated to obtain a maximum production for each individual piece.

The Reed-Prentice Company, of Worcester, Mass., placed the first of these single-process automatic lathes into actual operation, and much to the satisfaction of all concerned the production was increased from 25 to 50 per cent. Additional machines of the same type were then installed in larger batteries and in each case the production was increased proportionately.

The theory of establishing a single speed and single feed was to eliminate the judgment of the operator and to predetermine the day's output. If this was not obtained the cause was readily detected and almost as readily remedied.

In the machine referred to certain features were introduced which permitted the increase in production. The spindles were much shorter than in a standard lathe, while the bearings and journals themselves were longer than ordinary and much larger in diameter, with the journal bearings of the spindle carbonized, producing glass-hard surfaces.

The driving gears were extremely wide and of the herringbone type to permit smooth action under high speed without any perceptible vibration. The rack and pinion were hardened, as it was discovered that under actual production conditions the severe strains to which these parts were submitted finally bent the teeth very perceptibly and caused them to wear out rapidly.

The handwheel type of tailstock was replaced by a cam attachment for quick approach and withdrawal of the spindle, permitting a travel of from one to three inches according to the requirements of the work.

In order to obtain the squaring of the shoulders during the actual process of turning, a back-arm attachment was incorporated, actuated by the travel of the carriage so that when the longitudinal turning was completed the shoulders were simultaneously finished, thus producing the squaring operation at practically no additional cost. This, however, was not an absolutely new feature, having been previously employed.

To further assist in speeding up production multiple tools are used, and when the pieces are in sufficient quantity and adapt themselves to multiple operations, single-purpose machines of special design are brought out.

A very simple but most efficient method for securing quantity production is to use several arbors, some for loading while the others are working. Also, when applicable, a punch press is used for an arbor press, simultaneously loading one arbor and unloading another, this of course being used only where a battery of machines are operating on the same kind of work and call for a number of arbors of the same size, and where a conveyor is used to carry the work from the press to the lathes and return.

Air cylinders and quick-action, mechanically operated chucking or gripping devices are used wherever possible. Magnetic chucks and plates are also in extensive operation.

Lubrication. The seriousness of having 25 to 100 separate oil holes spread out promiscuously all over a machine is beginning to be realized. The neglect of any one oil hole invariably causes a hold up of production and may mean the entire dismantling of the machine. Therefore it becomes obvious that to control the lubrication from one point is decidedly advantageous. This is accomplished either by supplying a reservoir having gravity feed, by gear pumps delivering lubrication to the various bearings, by the use of the splash system, or by use of force-feed oilers. In fact, there are several methods, all of which are worthy of consideration.

Safety Devices. The working forces of automobile factories comprise many who never saw a machine tool prior to their employment, and it is this class of help that has made it necessary to safeguard every moving part of a machine to prevent them from getting injured. Years ago gears were left exposed and shafts allowed to run in the open, but the machines of today must include guards over every part that is in the least dangerous. Projecting shafts must be guarded, and where it is impossible to supply guards as part of the machine, rails or nettings must be secured around the machine to prevent any possibility of injury.

INFLUENCE OF THE AUTOMOBILE ON GEAR CUTTING AND GEAR-CUTTING MACHINERY

By Henry J. Eberhardt,[1] Newark, N. J.

During the past 20 years the interest of many of our engineers has been especially centered on the successful production and operation of automobiles and particularly automobile gearing.

To produce perfect and noiseless gearing, the trend of effort in gear making has been to produce accurate and rigid machines and cutters. The evolution of these elements divides into periods of great activity. The first period is that of the use of forms, and cutters made to the tooth form, nearly all of the industrial spur and heavy bevel gearing being cut by these means at the present time. Many early gear-cutting machine designs have become obsolete—the 1899 catalog of a prominent international machine-tool dealer illustrated thirteen gear-cutting machines, only three of which are being made today. Machines of this type have been redesigned to use the new alloy high-speed-steel cutters, and are, in the main, rugged examples of specialized automatic machines for the production of gears. As a rule, however, these machines will stand more punishment than the high-speed-steel cutters they use.

The second period is that of the use of gear-tooth generating machinery designed to generate tooth curves from the basic mechanical elements, the straight edge and the circle.

Great credit for early leadership in this period of gear-tooth generation is due to Edward Sang, who in 1827 read a paper before the Royal Scottish Society of Arts, the principles of which he finally crystallized in a treatise published in 1850 and entitled A New General Theory of the Teeth of Wheels.

In this work Professor Sang described a gear-generating machine using a rack-shaped cutter for generating all numbers of teeth; and also a generating machine using a pinion-shaped cutter for the same purpose. All successful gear-generating machines of today are but modification of one or the other of these two types.

The larger proportion of automotive gearing has been made by machines in this second group. However, the exacting requirements of very high-speed gears are not altogether satisfied. Many deviations from theoretical tooth curves have been made, and many changes in the proportions of gear-tooth sizing have been tried, with varying degrees of quiet running at critical speeds.

The third, or present, period of gear making is that in which the cutters are ground after hardening, and which is very prominently exemplified in the recent production of hobs with teeth ground on the top and sides; and also in which the gear tooth is ground after having been hardened. It appears that we are at the very threshold of this period. Several factories are rough-forming their gears on machines of the first and second groups and finishing by grinding.

With finish-grinding of the teeth it is becoming apparent that theoretical generating processes are not essential for the first cutting operation in the soft material. This has led to the production of simple specialized roughing machines, several having multiple spindle features for operating upon more than one blank at a time.

As high-speed-steel cutters are subjected to a melting-point heat in the hardening process, their surfaces become somewhat roughened and oxidized; therefore the value of grinding these cutters, even for roughing purposes, is clearly appreciated by the manufacturers of large quantities of high-grade gearing in a keen competitive market. Grinding such cutters on the top and sides, as well as on the front face of their cutting teeth, removes the roughened layer of oxidized steel and leaves the cutting edges smooth and keen, giving them cutting and wearing qualities much superior to those of an unground cutter.

These refinements of accurate gear making have brought gears to a more advanced state of perfection than the bearings of the shafts carrying them. In the general industrial field, machinery is designed relatively heavy—up to the point of clumsiness—and toothed gearing is given a large factor of safety. Considering

[1] Secretary, Newark Gear Cutting Machine Co., Mem. Am.Soc.M.E.

the automobile as a machine, it is designed relatively light—down to the breaking point—and yet is surprisingly efficient and lasting. Light gear bearings mounted on a flexible foundation will throw the gears out of position for the correct operation of exact tooth curves.

There is also a doubt in the minds of many engineers as to the desirability or mechanical value of adhering to theoretically correct tooth curves. Mr. Hugo Bilgram, in his U. S. patents granted in 1904 on a process and a machine for modifying the shape of gear teeth, refers to the humming noise of theoretical-form gears when running at high speed in the following words:

> This may be accounted for as follows: The teeth of wheels, when properly constructed, are made so that one pair of teeth make contact before the exit of the preceding pair, and for a sensible space of time two pairs of teeth remain in simultaneous contact. When the teeth are formed theoretically correct, the pressure to be transmitted will be uniformly shared between the two points of contact while two pairs are in contact, and upon the exit of the receding pair will suddenly fall upon the one pair still remaining in contact. As the succeeding pair come into contact the pressure is again suddenly divided between the two points of contact. This sudden change of pressure and especially the fact that the entering tooth will be expected to instantaneously take one half of the full pressure, readily accounts for the series of shocks manifesting themselves in the humming noises. This noise may be materially reduced if the teeth are so formed that each tooth shall at first take only a small fraction of the pressure to be transmitted and that, as the movement proceeds, the pressure upon the approaching pair shall be gradually increased, while that of the receding pair shall be correspondingly reduced, so that the pressure shall be transferred gradually instead of suddenly from one tooth to the following one. This can be obtained by slightly relieving either at the point or near the base, or both, the surface of the otherwise correctly formed tooth.

In 1902 the author used a gear-generating hob to obtain a similar result. Various successful modifications of tooth forms are being used today. One of the most prominent to be rapidly accepted is a spiral bevel gear, the bearing surface of which is relieved at the large and small ends of the teeth, giving smooth operation even under slight shaft and bearing deflections. The straight-tooth bevel gear is being made with tooth lengths of one-quarter the cone distance, whereas formerly the lengths were from one-third to one-half of the cone distance. Many other variations and special forms are being advocated.

RELATION OF POWER PRESSES AND DIES TO THE AUTOMOBILE INDUSTRY

By Henry J. Hinde,[1] Toledo, Ohio

The art of producing sheet-metal stampings from a flat sheet while cold has made marked progress in recent years, and many articles are now made of sheet metal which were formerly produced by casting or forging, or in a lathe, milling machine, drill press or at the bench.

Forming and stamping operations especially have in many classes of work become very complex, and the art of drawing sheet metals, stimulated by the enormous demand of the automobile industry in particular, calling for most intricate shapes, has reached a state of perfection hardly imagined possible a few years ago. The results achieved by the ingenuity of the present-day press and die designers, and to no small degree also by the metallurgist, who comes into consideration through his improvements of the physical qualities of the metals used, are indeed revelations in economy of production, strength of stamped articles and the absolute interchangeability and beauty of appearance of the finished products.

The development of power presses, together with that of dies and special tools, has been so marked in the last twelve years, principally because of the demand for intricate stampings for the automobile trade, that it is believed a far greater advance has been made than at any other period in the history of the business. This development has not wholly been confined to the working of sheet metal, for, as previously stated, the demand for accurate duplication of parts and the great quantities in which they are desired has resulted in power presses being used for sizing forged-steel parts which were formerly finished by means of saddle milling and similar operations. It has been found that manufacturers can produce greater quantities with much greater accuracy and with such a reduction in machine-shop production expense by the use of what is known as knuckle-joint or cold-swaging presses in sizing the finished working surfaces on these forgings, that a number of equipments have been installed for work on steering knuckles, brake levers, connecting rods and other similar forgings and castings. These presses are built in sizes capable of exerting a pressure up to 2000 tons and over, and it is claimed that size limits of 0.001 in. can be successfully maintained in operations of this character.

Although this marked advance is due to the automobile industry more than to any other one factor in recent years, at the same time the economical production of motor cars was made possible solely on account of the ability of the press and die manufacturers to successfully control the flow of the cold sheet metal into certain forms and shapes, by means of properly constructed dies and presses of such power and design that wonderful results have been obtained. As an illustration of this a wire-wheel hub is shown in Fig. 1.

This hub requires a blank $16\,^1/_2$ in. diameter and $^5/_{32}$ in. thick. Attention is called in particular to the numerous niches or pockets successfully formed into the circular shape, and also to the fact that the stamping was first drawn to a considerable depth at the narrow neck. The end of the neck or bottom of the stamping was then removed and this metal was made to flow back and expand to a considerable degree beyond its former small diameter without even stretching or thinning the metal in the reforming operations,

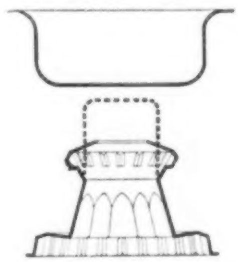

Fig. 1 Pressed-Steel Wire-Wheel Hub Formed from Blank $16\,^1/_2$ in. in Diameter and $^5/_{32}$ in. Thick

thus proving conclusively how successfully the metal was controlled and forced to flow back into its larger diameter with an opening in the bottom much smaller than the former small diameter of the neck of the stamping.

In the production of brake drums, front and rear hubs and spoke flanges the conditions that have to be fulfilled by the dies are that the product shall be absolutely interchangeable; that no machine work shall be performed upon the stampings when coming from the press, excepting some reaming and thread cutting; and that the strength of the material shall remain unimpaired. In addition it is imperative that all cylindrical parts be smooth and true and of standard diameter, allowing less than the commercial tolerance of variation. The work involves a most careful planning of the interrelation of the several operations, so that at no time the material shall be overstrained or reduced in thickness, and that the dies shall not be subjected to excessive wear in order to maintain uniformity of size.

A straight-column press has been developed especially for such work by the Toledo Machine and Tool Company which is of unusually rugged proportions and weighs about 145,000 lb. It is double-geared with a ratio of 40:1 and fitted with a very powerful friction clutch in combination with an effective brake and hand-lever control, so that the machine may be started or stopped at any part of the stroke of the slide up or down. The frame consists of four pieces—the bed, the two uprights and the crown—which are held together by four massive tie rods passing through the said crown, uprights and bed. When the frame is assembled these tie rods are heated. The nuts are then screwed home and the rods permitted to cool. In this manner, through the tendency of the rods to shrink, an enormous pressure is exerted by the rods upon the frame that renders the entire structure practically an integral one and brings all the working stress upon the tie rods.

Axle housings are made of steel plate up to $^5/_{32}$ in. in thickness, and the requirements are that the stampings be perfectly straight and flat so that when the two halves of a housing are joined

[1] President and General Manager, The Toledo Machine and Tool Company.

together by welding they form a perfect casing without warp. A powerful double-crank press developed for this purpose weighs about 95,000 lb. and is capable of forming and stamping cold at one blow axle-housing halves about 40 in. in length of steel plate up to $^{5}/_{32}$ in. in thickness, the blank having been cut previously to proper shape.

One modern form of toggle drawing and deep-stamping press, such as is used for making engine pans, radiators and other similar articles of the comparatively lighter gages of metal, has two slides, an outer slide for clamping the blank and holding it while the work is being drawn, and an inner slide for doing the drawing, stamping and forming operation. Presses of this character are also made in the double-crank type with a considerable distance between the uprights and weighing as much as 600,000 lb. Such presses are used for body forming, for making cowls, dashes, fenders, etc.

The forming of channels and side rails for automobile frames and similar requirements has resulted in the designing and building of special presses particularly adapted for this work. The side rails, for instance, are preferably first blanked in a double-crank press as much as 218 in. between the uprights. The largest sizes of these presses weigh in the neighborhood of 500,000 lb.

The forming operations are performed in a specially designed press, the outstanding feature of which is that the operation is diametrically opposite that of the ordinary toggle drawing or deep-stamping double-action presses. The channel-forming press has a movement entirely mechanical that brings the tools down and at rest on a flat blank, or sheet, by means of a toggle motion, and in this position the machine is capable of a resistance pressure upward of 2000 tons. While this first toggle movement is at rest, another movement is brought into play, forming up the sides of the channel or frame. The machine in its operation completes the one cycle when the stamping lies on the face of the dies completely formed, with the result that the web, or bottom of the stamping, remains as flat as it was in the original sheet. In other words, the bottom or web of the channel is held perfectly flat during the operation. Several of these presses have been built and are in most successful operation. They weigh upward of 600,000 lb. each. One of these presses with five men will do the work of three hydraulic presses with fifteen men, to say nothing of the large force required to straighten the rails when hydraulic presses are used.

Still another interesting feature that the automobile trade has developed is the smoothing-out process for certain of its stampings, more particularly the tapered, stamped-steel radiator front or casing. Because of its slightly tapering form it was found difficult to produce a stamping for this piece so free from waves, or buckles, that it would show smooth over the finally enameled and varnished surface. The requirements were successfully met by developing a set of tools to receive the finished stamping and allow an exceedingly small space for water to flow just inside of the stamping around the steel form supporting the stamping. It was necessary to exert a pressure of some 2000 tons on the outer surface of the stamping to prevent seepage or leaking, and to supply water to the die through a $^{3}/_{4}$-in. pipe by means of an accumulator with sufficient force to smooth and iron out all of the unevenness and waves in the original stamping.

THE INFLUENCE OF THE AUTOMOBILE ON LATHE PRACTICE

By Ralph E. Flanders,[1] Springfield, Vt.

Within the memory of the author, the design of machine tools has been deeply affected by a number of influences. The first of these was the bicycle craze of the 90's. An important result was the development of the hand screw machine in the direction of heavier drive and feeds and stiffer structure to meet the demands of work like hub forming. Another line of improvement lay in the design of highly specialized machinery for the making of a single part. Such machinery had been almost unknown up to that time, as the bicycle gave the first opportunity since Civil War days for continuous production on work of moderate size. Machines of this new type were applied to spoke and nipple making, hub drilling, chain-link manufacture, sprocket and gear cutting, etc.

The second great influence was the invention and development of high-speed steel by Mr. Taylor and his associates. The effect of this invention began to be strongly felt in the first five years of this century, and was the chief factor in a continuous policy of redesigning for cutting power and rigidity which has been going on until the present time.

Meantime the high-speed tools themselves have been improved, while the ability to treat them and, still more, the courage to use them to the limit, have been steadily developing. As a consequence there has been a contest between the machine and the high-speed cutting tool much like the classic rivalry between the projectile and the armor plate. As soon as a machine was designed to use high-speed tools to the limit, better tools were provided and speeds and feeds were demanded which were beyond the capacity of any known machine.

The last important influence was that of the automobile. This statement is made advisedly, as the war, so far-reaching in its effect on human life and history, made really little lasting impression on machine-tool practice. A few special processes were fostered, such as thread milling and form grinding. A really revolutionary advance was made in gaging, inspection, and interchangeability in general. This was induced by the necessity for assembling together parts made in widely scattered factories. But the effect on machine tools themselves and their actual operation now appears to have been negligible.

If we study the influence of the automobile on machine-shop practice, we can see why this is so. The industry, long before the war, developed to the point where parts were made in such quantities that most of the operations could be made continuous, one machine or many being set up and tooled for a single operation on a single piece, remaining on this operation hour after hour, day after day, and month after month. In spite of the immense amount of machine-shop work involved in the activities of the war, only a minor percentage attained to this standard condition of automobile manufacture. For the most part it was ammunition and small arms only that were made in continuous production.

Now this condition of continuous production is the ultimate goal of manufacturing development. It demands and employs every last possibility in cutting qualities of steel, power and accuracy in machines; and particularly in skill in the design of fixtures, tool outfits, and methods of machining. The fact that this goal was reached so early in American automobile manufacture explains why the war did not stimulate new developments in machine-tool practice, but rather acted as a retarding factor on the whole.

The influences just described have affected all varieties of machine tools, but this paper is limited to a discussion of lathe practice as affected by the automobile. By lathe practice is meant not only engine lathes, but turret lathes, automatic lathes, automatic screw machines, and other machines in which cutting tools act on rotating work.

For the moment, at least, machines of the best design are more than adequate to the demands of the best high-speed steel now available. Development has therefore taken entirely new directions, and the present is a most favorable moment to examine its progress.

Present progress in lathe practice is in two radically different and, to some extent at least, opposed directions. The one relates to the expanding of the machine by giving it a number of spindles with a corresponding number of tool positions. This is best seen in the multiple-spindle automatic screw machine, now used almost exclusively for standard bolts, screws and studs, and for other parts made in large quantities. It is more costly than the single-spindle automatic, but not much more complicated, the cost arising principally from the extreme accuracy necessary in the indexing and spacing of the spindles. The difficulty of obtaining this accuracy is the limiting feature of the machine, but its scope is constantly increasing.

As applied to larger machines for chuck work on castings, forgings, etc., the machine becomes more elaborate, approaching the conditions of a number of separate machines united on one base. This results in considerable complication and cost, but spectacular producing capacity in many cases. There is the further advantage

[1] Manager, Jones & Lamson Machine Co., Mem. Am.Soc.M.E.

that the tooling—being spread broadly over the different positions—is simple, open, and easily adjusted.

The second line of progress is in the direction of providing machines having a large surplus of driving and feeding power and of rigidity. The limitation on output and accuracy now becomes an entirely new one. Instead of asking, "What will the machine stand?" or "What will the tool stand?" we ask "What will the work stand without springing, breaking, chattering, or tearing from the chuck?" The engineering problem thus becomes one of operation sequence, support for the work, tool design, and—in some cases—design of the work itself.

FUNDAMENTALS OF INTERCHANGEABLE MANUFACTURE

By Chester B. Lord,[1] Battle Creek, Mich.

In dealing with so broad a subject as interchangeable manufacture, it is well to remember that in the course of time many false traditions and pseudo-scientific conditions are built around a process or system, either glorifying it unduly or condemning it beyond its deserts. This makes it necessary to be iconoclastic and tear down that we may build upon a firmer foundation, sometimes rearranging the former material and sometimes rejecting it. Likewise, it is well to start out with certain fundamentals plainly stated, and any discussion or theory that contravenes these fundamentals is useless for our purpose.

The first fundamental is that no two things are alike; the second, that the difficulty of maintaining accuracy increases in geometric ratio with each added accurate dimension on the same piece; the third, that no machine or tool under stress can be accurate; the fourth, that the manufacture of interchangeable parts in quantity is a matter of percentage; and the fifth, that irrespective of the method used, quality is a matter of insistence.

The nearest approach to mechanical perfection that we know of is found in the Johansson gages, or was until the advent of the Hoke gages; but within their limits these are by no means interchangeable and the interferometer shows not only a variation in size but a difference in parallelism of the same piece.

Securing one very accurate dimension on a piece is a comparatively simple matter. The ease of securing two accurate dimensions, however, depends upon the relation of the second to the first. The figures given in the following table are based upon practice and general impressions, but the author believes them accurate enough to justify their publication for the purpose of showing the high cost of unnecessary accuracy:

No. of Dimensions on One Piece	Probable Number of Perfect Pieces	Per Cent Estimated Increase in Ratio of Cost per Operation
1	100	0
2	90	30
3	50	75
4	15	100
5	5	200
6	0	500

In making the foregoing statements the author has in mind automatic and other machines where the close-dimension work is done at one setting and in manufacturing quantities. Some will dispute the figures given in the table and will declare that it is not good practice to attempt finishing pieces in the automatic, but that they should be roughed out there and finished on a shaving lathe or elsewhere. This brings us to our third fundamental and we may ask, Why should they not be finished complete when a good automatic must, in the nature of things, be (and is) as accurate as a single-purpose machine *on a single accurate dimension?* It is not accurate on several close ones, however, and accepted practice confirms this statement; and the reason why it is not and cannot be accurate is because of conflicting stresses.

There are many firms the engineering departments of which really believe they are producing an interchangeable product of close dimensions, but their inspection and manufacturing departments could tell a different story. It is not bad workmanship or lax inspection that is responsible for their failure to produce such work, but the—ofttimes—unnecessarily close tolerances specified on unimportant dimensions, or the insistence of close ones on several dimensions of the same piece, and it is well to stop and consider what may happen, say, to a piece of apparatus after it has been in service for some time when initially it required the centers of two shafts to be held within one-half thousandth of an inch.

Interchangeable manufacture requires both *relative tolerance* and *specific tolerance.* Relative tolerance has to do with its relation to the part to which it assembles and does not necessarily affect the tolerance of the specific dimension. Specific tolerance is that tolerance on a specific dimension required to render a particular part easy to manufacture, or to take care of the wear on tools. Any part increases in cost with each succeeding operation, and the probability of loss should decrease in the ratio of its added value. This result should be obtained, first, by a design having in view its relation to subsequent machining operations, and, second, through the proper sequence of operations relative to their difficulty, and sufficiently divided. This leads us up to the question of registration. Automobile-engine builders cast lugs on their cylinders to insure parallelism of bore; adding-machine and phonograph castings sometimes have bosses cast on, to take the pressure of milling or drilling operations. It is also true that sometimes we insert a pin in a drilled hole to guard against movement, but we do it only at times and usually as a matter of convenience, whereas it is a matter of necessity; and it will usually cost less to drill special holes or machine special lugs for registration and resetting than to attempt to do the work in fewer complex operations.

And nearly as important as registration is the question of clamping. One of the fundamentals laid down was that a machine under stress could not be accurate. This is just as true of a piece being machined, and unless a part is designed with its subsequent machining operations in view; unless it is supported sufficiently near its pressure centers; unless it has a three-point support with the holding or clamping pieces immediately over them (and in the case of a drill jig, independent of the part that carries the bushings), then that piece cannot be accurate. This is true of drilling always, of milling generally, and of turning sometimes.

How tolerances shall be indicated; whether they shall be identical, independent, or overlapping; what the law of probability and what actual trial demonstrate as the probability of overlapping or identical tolerances interfering; the percentage that may be expected at different parts of the tolerance, and the lessons to be learned therefrom are subjects calling for extended treatment by themselves. The same is true of inspection, of machining methods, of analysis of product.

The automatic screw machine will, of course, always be with us, for in that we meet ideal manufacturing conditions as nearly as they may be met. But the fact that the single-spindle screw machine persists and is even exclusive in the small-part field, is still further corroboration of the price we must pay for accuracy. The question of accuracy is of course relative, as is the question of rigidity of machine; but it is important in its bearing upon the cheapness of manufacture by determining the number of cuts, retapping, reaming, grinding, etc., that are necessary.

The law of compensation applies to mechanics as well as elsewhere in industry, and when we attempt to work to closer limits at the expense of increased operations, we must pay somehow. This is not to be considered as an argument against such a procedure, but an appeal for common sense in interchangeable manufacture—not to make the work easier, but to reduce the cost—and the firms that are really making a good interchangeable product are those that have analyzed all the different conditions and hold the extremely accurate dimensions at a minimum.

Neither should it be thought from what has been said that close dimensions may not be necessary or desirable. Some companies require them much closer than do others. It then becomes a question of whether the price received for the finished apparatus is commensurate with the close limits imposed. If not, then it is a matter of increasing the tolerances so as to permit manufacture on a cheaper basis. In other words, the percentage of rejections that can be tolerated must be figured out and kept within that limit. For instance, on an apparatus costing \$10.00 for which a liberal price is asked and received, an allowance of 50 cents per apparatus for rejections may not be excessive. If, on the other hand, the price is close, 50 cents may mean the difference between profit and

[1] Works Manager, Advance-Rumely Co., Mem. Am.Soc.M.E.

loss. This is a matter of policy to be settled by the administration and not by the shop, although we very often lose sight of this fact.

In the author's opinion there are no such things as close tolerances. All are relative and we only court trouble when we try to take too many steps at once. One-half thousandth is only five per cent of ten thousandths, and the chance of securing that accuracy in quantity in one step is about five per cent multiplied by the extra cost. But one-half thousandth is *fifty per cent* of one thousandth and the probabilities are increased in the same ratio, so we may lay it down as a truism that subdivided operations are a function of accuracy.

Analyzing our fundamentals, we find that there are three ways in which interchangeable parts may be secured:

a By obtaining a percentage of good ones, with close tolerances
b By giving individual attention to each piece
c By employing liberal allowances

The first is wasteful and the second is not manufacturing; the third one means liberal unnecessary allowances and close necessary ones, with the operations so divided that each individual working upon the part has but one thing to do. Thus, on a small shaft with six diameters all ground to a 0.0005-in. limit, there should be six roughing and six finishing operations because different wheels may be used; because less skilled men may be employed with less chance of scrap; because the wheel will be in better condition and will not need dressing so often and the operator will not have to change his sense of proportion, "hog off" material one moment and hardly touch it the next; because the finishing operations may always be done on the most accurate machine; and last, but not least, because as a rule one man can finish more work to close dimensions in four operations than four men can in one operation.

Let us not delude ourselves, however, that interchangeable manufacture or standardization is all profit and has no penalties. The French, even in large business, recoil from the idea of standardization, and this feeling has saved them through the ages from the rigidity of an arrested civilization. I am not competent to say whether the artistic qualities of the French are the result of their fight against standardization or whether it is the cause. Suffice it to say that no country that manufactures on the scale that France does and employs standardized methods, can either duplicate her excellence of manufacture or produce the artistic or scientific results she obtains. We must somehow pay for the repetition we call standardization, specialization, or interchangeability, and as usual the toll is collected from the intellectual.

DISCUSSION AT THE MACHINE SHOP PRACTICE SESSION

THE discussion was opened by Luther D. Burlingame[1] who spoke of the influence of the automobile both on the use of the machine tool in their manufacture and to its use in providing the tool and gage equipment needed for quantity production. In the case of the milling machine, power feeds in all directions had been added, with automatic quick return, with constant-speed drive and gear changes for the feeds and spindle speeds controlled by levers conveniently adjusted; while in the case of gear-cutting machines, the call for gears of a higher degree of accuracy and strength, combined with quiet running, brought new problems. Much study, he said, had been given to the question of the worm drive and to the development of steels and other materials which had reacted on the industry in a way to increase very noticeably the efficiency and durability of machine tools. Machine tools are depended upon in the manufacture of gages and tools and in this field of work alone, he said, there has been a special challenge to increase the degree of accuracy and high grade of workmanship needed for the manufacture of the machines needed for producing this tool equipment.

J. A. Smith[2] spoke of the need for strengthening machine tools, expressing his belief in "lots of iron." Machines could have precision without being specialized, he said, the opportunity for specialization being greater in the larger manufacturing plant having a small variety of products. There should be plenty of power, so distributed in a machine that the place of power application should be the place of failure in case of overloading. He criticized the lubrication of machine tools, which he considered the least up-to-date feature.

Chester B. Lord[3] expressed himself as being dissatisfied with the lubrication of machine tools and criticized the builders in not taking the lead in making improvements along this line. He objected to "specialization" saying that "simplification" was needed. He also objected to the many speeds and feeds.

N. W. Dorman[4] took up the cudgels for the machine-tool builders on the matter of lubrication and spoke of the thought and care with which they had considered this problem.

F. O. Hoagland,[5] chairman of the meeting, then started a discussion of the color which machine tools should be painted. Chester B. Lord said his practice was to enamel all machines upon which girls worked white, while J. A. Smith thought he would like to have machines painted a light gray. C. W. Ripsch[6] said his company's practice was to use a battleship gray, and Roger B. Garvin[7] complained that each customer would want a different color should machine-tool builders commence such a practice.

In discussing punch presses, J. A. Smith again spoke for more material, such as bigger shafts, and for the location of bearings so that they would be accessible.

Forrest E. Cardullo,[8] who presented the paper by Mr. Hendrickson, was asked to close the discussion and spoke of the fact that tools which were not primarily used in automobile manufacture had also been improved. He took sides with the manufacturer on the subject of lubrication, maintaining that it should be the duty of some one to see that machines were properly oiled. He considered the value of weight of metal in machine tools an exaggerated idea; correct design would eliminate useless weight. He was also of the opinion that purchasers of machine tools always expected more of the tool than their original requirements and for this reason were apt to brand it as unsatisfactory.

A. C. Cooke spoke of a number of details of automobile practice and design which had been adopted by machine-tool builders. One of the most valuable outcomes of the relations of the automobile and machine-tool builder, he thought, was the coöperation between them which had resulted in improvements.

Sol Einstein[9] in a written discussion, mentioned many of the improvements to milling machines which had come about through the demands of the automobile industry and of the details of automobile design and practice which had been adopted by machine-tool builders. He summed up his remarks by saying: "The automotive industry asked of the machine-tool designer automatic machines, either through modification of standard designs or machines of entirely special design—quick-acting fixtures, either hand-operated or automatically operated—more powerful and stronger machines occupying a minimum amount of floor space. On the other hand, the automotive industry supplied the machine-tool designer with a vast variety of highly successful mechanisms and constructive details, from which he could draw freely such elements and such ideas as could be adapted to the design of machine tools."

Following the discussion of these papers, Chester B. Lord presented his paper on the Fundamentals of Interchangeable Manufacture. The discussion of the paper turned to the question of tolerances, location surfaces and standards. Those participating in the discussion were Messrs. Smith, Cardullo, Hoagland and Lord.

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[1] Industrial Supt., Brown & Sharpe Mfg. Co., Providence, R. I. Mem. Am.Soc.M.E.

[2] Genl. Supt., General Electric Co., Schenectady, N. Y. Mem. Am.Soc.M.E.

[3] Works Manager, Advnce-Rumely Co., Battle Creek, Mich. Mem. Am.Soc.M.E.

[4] Machine Designer, Toledo Machine & Tool Co., Toledo, Ohio. Jun. Am.Soc.M.E.

[5] General Manager, Reed-Prentice Co., Worcester, Mass. Mem. Am. Soc.M.E.

[6] Chief Engr., Joyce Cridland Co., Dayton, Ohio. Mem. Am.Soc.M.E.

[7] Director, The Garvin Machine Co., New York, N. Y. Jun. Am.Soc. M.E.

[8] Chief Engr., The G. A. Gray Co., Cincinnati, Ohio. Mem. Am.Soc. M.E.

[9] Chief Designer, Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio. Mem. Am.Soc.M.E.

Limitations of Stokers Using Mid-West Coals

Two papers dealing with the limitations of stokers using Mid-West coals were presented at the Fuel Session of the A.S.M.E. Spring Meeting in Chicago, and appear below in slightly abridged form.

In the first paper the author, Mr. E. H. Tenney, discusses the limitations imposed on mechanical stokers by the use of Mid-West coals, which are characterized by higher moisture, volatile and ash contents as compared with Eastern coals; the limitations imposed by air supply and by the design of the furnace; and the effect of these various limitations on stoker operation. It is his belief that in general the application of mechanical stoking equipment to the use of Mid-West coals has proved to be eminently successful. Specially designed arrangements for air supply and to facilitate ignition of the fuel have been provided; and furnace volumes and gas passes have been scientifically studied, with the result that the most difficult problems—namely, those incident to operation at high rates of combustion—have been satisfactorily solved.

According to the author of the second paper, Mr. John E. Wilson, less progress has been made in the direction of securing efficient combustion than in any other immediately connected with stoker service. In the case of natural-draft chain-grate stokers the greatest losses are those due to the dry chimney gases and the carbon in the ash, and the possibility of making a material gain in the efficiency lies to a great extent in the ability to reduce these two losses. A certain amount of air admitted over the fire has been found advantageous when high-volatile coals are used, such as those found in the Middle West.

Capacity is governed principally by the available draft and ratio of total boiler heating surface to the grate area. Chain-grate stokers provided with forced draft operate successfully under continuous high rating, respond quickly to load requirements, and will successfully burn coal containing a large percentage of ash which fuses at a comparatively low temperature.

Underfeed forced-draft stokers in the Mid-West districts have a large number of very satisfactory operating records to their credit both from an efficiency and a capacity standpoint. Some types of overfeed stokers have also been used with good success in this section where only a limited capacity was required and suitable coal was available.

The necessity of securing improved refractories as well as improving the furnace design is emphasized by the difficulties encountered with the brickwork when forced firing is employed, and it is possible that these may prove factors governing the capacity which will be obtained in future installations.

LIMITATIONS OF MECHANICAL STOKERS UTILIZING MID-WEST COALS

By Edward H. Tenney,[1] St. Louis, Mo.

A CONSIDERATION of the limitations of mechanical stokers imposed by the use of Mid-West coals is pertinent at this time on account of the increasing application of mechanical-stoker equipment throughout the Middle West, and on account of the tendency on the part of some to overlook the fact that such limitations exist.

Limitations Imposed by the Fuel

Mid-West coals are classed as bituminous or sub-bituminous, and are characterized by the higher percentages of moisture, volatile and ash which they contain as compared with Eastern coals (see Table 1). On account of these characteristics they are inherently

TABLE 1 COMPARISON OF EASTERN AND MID-WEST COALS

Constituents of Coal	An Eastern Coal[1]	A Mid-West Coal[2]
Moisture, per cent	2.21	11.90
Volatile, per cent	15.78	31.06
Fixed carbon, per cent	71.65	41.62
Ash, per cent	10.36	15.42
	100.00	100.00

[1] Pocahontas. [2] Southern Illinois.

difficult to handle satisfactorily on a stoker, but they present possibilities for even greater operating economies than in the case of Eastern coals because of the opportunities provided for even firing, close regulation of air supply, high temperatures, and a continuous and regular elimination of ash.

Moisture. The moisture content in Mid-West coals ranges from 6 per cent to 16 per cent, depending largely upon the amount of surface moisture which may be present. This moisture absorbs heat from the furnace for its vaporization and superheating and tends to reduce furnace temperatures, often to such an extent as to be the limiting factor in the obtaining of proper ignition at high rates of combustion.

Volatile. High volatile content is the one redeeming feature of the Mid-West coals, inasmuch as this quality tends to facilitate ignition. With other furnace conditions favorable to the proper combustion of the liberated gases, there is little doubt but that the limit of stoker capacity is increased by the increased percentages of volatile.

Ash. The ash content of these coals varies from 10 per cent to 16 per cent, depending upon the method of mining and storing, and presents one of the most difficult limitations to their use on mechanical stokers. Large quantities of incombustible matter interfere with combustion if allowed to remain in the active fuel bed. This is increasingly true at high ratings, especially so on account of the low fusing temperature of the ash, which results in the formation of clinker and the prevention of proper air supply. The efficiency of the combustion process and the effectiveness of the stoker for burning large quantities of coal at high rates of combustion are seriously limited by this clinkering quality in the Mid-West coals. This characteristic can be closely approximated from an analysis of the ash, although the grouping of elements and the reactions at different temperatures vary to such an extent that no rule can be applied. Table 2, prepared by Mr. Edwin Lundgren,[2] shows the increase toward fusibility as percentages of certain constituents change, more particularly the ferric oxide. Ash from Mid-West coals comes between "clinkering" and "bad" in the table.

TABLE 2 TYPICAL PERCENTAGE ASH ANALYSES

Composition	Non-Clinkering	Fair	Clinkering	Bad
Silica (SiO_2)	54.67	46.23	46.40	43.50
Aluminum (Al_2O_3)	41.95	31.93	16.45	17.10
Ferric Oxide (Fe_2O_3)	Trace	14.54	18.15	28.10
Calcium Oxide (CaO)	1.82	5.04	11.80	5.30
Magnesia (MgO)	1.42	2.26	4.63	0.75
Sulphur	0.55	1.50	3.00	2.70

Limitations Imposed by Air Supply

The subject of air supply to stokers utilizing Mid-West coals is of equal fundamental importance to that of the fuel itself. In the burning of low-grade coals the distribution of air through a fuel bed heavy with ash and clinker is not conducive to its proper mixture with the combustible gases, with the result that combustion is incomplete when the gases have passed from the furnace. Such coals require large quantities of excess air, which, on account of the interference set up by the fuel bed, tend to travel in stratified streams. The mixing, therefore, is incomplete and the combustion slow. Where natural draft is utilized, it is obvious that air supply is one of the important limiting factors as to efficiency in the use of these coals. Where artificial draft is utilized, air supply is seldom a limiting factor. Care must be exercised, however, in the specification of equipment for varying qualities of fuel in order that provision may be made for sufficient capacities when burning low-grade fuels at high ratings. This involves the use of quantities of excess air at high temperatures and may become a serious limiting factor.

Limitations Imposed by the Design of the Furnace

The size of the combustion chamber, in that it determines the length of time during which the mixture of combustible gases and air will remain in the furnace, determines the amount of fuel that can be burned, and hence determines stoker capacity. For high ratings where large quantities of gas are produced and large volumes of air supplied, a limit is reached when the furnace gas and

[1] Chief Engineer of Power Plants, Union Electric Light & Power Co. Mem. Am.Soc.M.E.

Slightly condensed from a paper presented at the Spring Meeting, Chicago, Ill., May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

[2] Vice-President and Chief Engineer, Frederick Engineering Co., Frederick, Md., Assoc-Mem. Am.Soc.M.E.

the oxygen in the air supply cannot remain in contact in sufficient time to completely burn the gases. With 50 per cent excess air and burning at the rate of 50 lb. per sq. ft. of grate area per hour, developing to within one-half of one per cent complete combustion of the flue gases, the Bureau of Mines[1] have determined that Illinois coal requires 11.9 cu. ft. of combustion space per sq. ft. of grate area as compared with 4.8 cu. ft. in the case of Pocahontas coal. In other words, to obtain like results at very high ratings the Mid-West coals require about two and one-half times as much furnace volume as the Eastern coals.

For high overratings with Mid-West coals very large volumes of flue gas must be handled. Resistance to the passage of these gases through the setting increases as the square of their velocity. At high ratings, therefore, the drop in pressure through the furnace and boiler increases rapidly, at 200 per cent of rating becoming four times the drop at 100 per cent rating, and at 300 per cent of rating becoming nine times the drop at 100 per cent rating. Draft pressures must therefore be adequate to overcome these high frictional losses or capacity will be limited. Location of baffles to give uniform velocities throughout the path of gas travel is an extremely important phase of boiler and furnace design which, until recently, has had too little serious attention and has been a limiting factor in boiler efficiency.

The problem of ignition offers another limiting factor in the operation of stokers using Mid-West coals, especially at high overratings. Furnace design must permit of the concentration of sufficient heat at the point of entrance of the fuel to accomplish a rapid distillation and strong ignition of the hydrocarbons. The necessity for, and the practice of, installing a properly designed reflecting arch to accomplish this is well known. The high volatile percentage of our Mid-West coals tends to facilitate ignition and is especially favorable when the volatilization may be accomplished rapidly and at comparatively low temperatures. This produces the greatest percentage of methane (CH_4), which is the simplest hydrocarbon and most easily consumed. Successful ignition also depends to some extent upon the size of the coal, smaller sizes igniting more quickly than larger lumps on account of the greater surface displayed to the heat.

Effect of Limitations on Operation

The effect of these various limitations in the case of chain-grate stokers utilizing natural draft is that maximum capacity is limited to the burning of from 40 to 45 lb. of coal per sq. ft. per hour, which may be somewhat increased at a large sacrifice in efficiency. Above this rating, however, the ash-pit loss increases excessively, and it is almost impossible to maintain ignition. In the case of forced-draft chain grates the limits as to rates of combustion are considerably higher, and greater flexibility of operation is also obtained through a more definite control of air supply. However, when the coal rate is increased beyond approximately 60 lb. per sq. ft. per hour, clinkers and slag complications make efficient operation difficult. In addition to this, temperature conditions at high ratings become such as to make furnace and brickwork maintenance a serious problem.

In the case of the overfeed type of stoker, operating under natural draft, a coal consumption somewhat less than that obtainable on the chain grate is generally recognized, this being approximately 30 lb. per sq. ft. per hour. Trouble from the avalanching of the fuel bed is reported beyond this rating resulting in breaks and bare spots within the fuel bed and temporarily limiting both efficiency and capacity. In the application of forced draft to overfeed types of stoker overratings may be somewhat extended. A test by the Bureau of Mines on a Murphy-type stoker developed a combustion rate of 50 lb. per sq. ft. per hour.

In the case of the underfeed stoker, particularly where equipped with multiple retorts and forced draft, a quick response may be had to all changes in load, resulting in an exceedingly flexible control. For continuous operation the maximum amount of coal which can be burned successfully seems to be from 900 to 1000 lb. per retort per hour. For high overratings over short periods a combustion rate of 1400 lb. per retort per hour may be established. The limiting features as to capacity and efficiency in the underfeed stoker utilizing Mid-West coals lie mainly in the high ash content of the fuel and its low fusibility, which at high overratings result in clinker formation and sometimes in the fusing over of the entire surface of the fuel bed adjacent to the dump plates. While such conditions are being rectified combustion is partially suspended, capacity limited, and efficiency low.

In conclusion, it may be generally stated that the application of mechanical-stoking equipment to the use of Mid-West coals has proved to be eminently successful. The peculiar characteristics of the fuel have called for especially designed arrangements for air supply and for ignition. Furnace volumes and gas passes have also had scientific attention, with the result that the most difficult problems, namely those incident to operation at high rates of combustion, have been satisfactorily solved. The particular type of stoking equipment best adapted to these coals may be specified as that one which most fully overcomes the many limitations to capacity and efficiency which have been found to exist.

[1] Bulletin No. 135 (1917).

CAPACITY AND EFFICIENCY LIMITATIONS OF STOKERS USING MID-WEST COALS

By John E. Wilson,[1] Chicago, Ill.

The cost of stoker repairs per ton of coal burned depends to a large extent on the quantity of coal consumed per square foot of grate surface, or its equivalent, rather than on the type of stoker used. The average cost of repairs to a number of chain-grate and underfeed stoker installations has been found to be 3.7 cents and 5.4 cents, respectively, the cost of repairs to the fans and air ducts required by underfeed stokers being included in the latter figure. The chain-grate plants mentioned will burn, on an average, 30 lb. of coal per sq. ft. of grate surface per hour, while the underfeed stoker plants will average 550 lb. per retort per hour.

In considering the repair and operating records from numerous plants, the fact has been brought out that the stoker is one of the most dependable pieces of equipment in the power plant. The stoker, up to the present time, has been primarily a labor-saving device. The importance of this feature has increased with wages, together with the uncertainty and scarcity of labor. The decision to install stokers in many plants has been governed to a large extent, if not entirely, by this factor. The saving in the cost of operation effected by stokers is frequently considered along with the saving made by the coal and ash-handling machinery. In this way the total saving often appears credited to the stokers alone. Since all or part of the coal-handling, and all of the ash-handling, equipment is applicable to a hand-fired plant, care should be taken to make a distinction between these figures. The quantity of steam required for driving stokers, also for draft fans, should in all cases be charged against stoker operation when considering these costs. The quantity of steam required for this purpose will vary from 0.3 per cent on stokers using natural draft to 3 per cent where induced or forced draft is used.

Mechanical Stokers from the Standpoint of Efficient Combustion

Upon considering mechanical stokers from the standpoint of efficient combustion, it is apparent that less progress has been made in this direction than in any other immediately connected with stoker service. The saving due to the increased efficiency obtained with stokers over hand firing will cover only to a small extent the fixed charges on the increased investment required by the stokers.

Chain-grate stokers operating under natural or induced draft have been used extensively through the Middle West for a number of years. In supplying coal to the stoker magazine it is the usual practice to feed it from an overhead bunker through chutes. In gravitating down the chute the various-sized pieces of coal have a tendency to separate from one another. This action causes the coal to be delivered in the magazine with the small coal in the center, increasing in size toward the ends. The result of this is a marked tendency for the fire to burn off unevenly. The use of overhead

[1] Traveling Engineer, Swift & Co. Mem. Am.Soc.M.E.

Slightly condensed from a paper presented at the Spring Meeting, Chicago, Ill., May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

lorries for weighing coal to the stoker magazine eliminates this condition to a large extent.

A large percentage of the screenings, or slack coal, used on chain grates will pass a $^1/_2$-in. mesh screen. In some cases this fine coal has found its way to the sieving pit in such quantities as to represent 15 per cent of the total amount of coal fed to the grate. As a rule the sievings are either conveyed back to the main coal bunkers, or returned directly by hand to the stoker magazine. A comparatively small quantity of this coal on the grates will be sufficient to upset conditions in the furnace, resulting in lower capacity and efficiency. Efforts to reduce the amount of sievings by providing air openings running diagonally across the links, also by substituting skids in place of rollers, have been only partly successful.

The design and location of the furnace arch have an important bearing on the operation of a chain grate, both from an efficiency and capacity standpoint. It is highly important that the hydrocarbons driven off from the coal in the distillation zone at the front of the stoker be consumed in the furnace before having an opportunity to come in contact with the heating surface of the boiler. The ignition rate is governed principally by the design of the arch, and this affects the quantity of coal consumed to a large extent.

The following figures are those of a representative heat balance from boilers equipped with natural-draft chain grates burning Illinois coal:

	Per cent
Heat absorbed by water	70.0
Heat loss due to dry chimney gases	14.5
Heat loss due to combustible matter in the ash	5.5
Heat loss due to burning of hydrogen	5.0
Heat loss due to incomplete combustion of carbon	1.5
Heat loss due to moisture in coal	0.5
Heat loss due to moisture in air	0.5
Heat loss due to radiation and unaccounted for	2.5
	100.0

It will be seen from this that the greatest loss from any two combined sources is from the dry chimney gases and carbon in the ash. This indicates that the possibility of making a material gain in the efficiency lies to a great extent in the ability to reduce these two losses. The importance of reducing the excess air is apparent, since some 40 per cent of the loss due to heat carried away by the dry stack gases results from the excess air admitted to the furnace. The most serious fault, perhaps, of the chain-grate stoker is the failure to provide adequate facilities for controlling the air supply to the furnace. Adjustable dampers have been installed on some natural-draft chain grates for this purpose, but the results obtained are only partly satisfactory. If attempt is made to burn the carbon out of the ash, it is found that an increased amount of excess air is admitted through the rear of the grate.

The short-circuiting of air through the well-burnt-out ash, in addition to carrying heat away from the boiler, tends to slow down the ignition and combustion rate on account of reduction in furnace temperature. On the other hand, if the fuel bed is carried well up to the water back, an excessive amount of carbon will be wasted in the ash. On account of the conditions just mentioned, after a certain point is reached the combined loss from stack gases and carbon in the ash remains approximately the same—a gain in one being offset by an additional loss in the other.

The baffle found on chain-grate stokers at the rear of the grate helps to prevent an excessive amount of air from finding its way into the furnace between the water back and grate. The condition which tends to discount the good to be derived from the baffle is the variation in size and nature of the coal, which makes it difficult to maintain a uniform length of fire extending up to the water back at all times. The stoker baffle is necessarily located in a place difficult of access, with the result that it is likely to be neglected.

Various experiments have proved that a certain amount of air admitted over the fire is an advantage where high-volatile coals are used, such as are found in the Middle West. This will be appreciated when consideration is given to the fact that practically no free oxygen passes through an active fuel bed of a uniform thickness which would be available for uniting with the combustible gases driven off of the coal soon after it passes into the furnace. With the present stoker design there is no doubt considerable air leaking in around the ledge plates, coal gate, etc., which furnishes in a more or less uncertain way some of the air required above the fuel bed.

The chain grate disposes of the ash very successfully, even from coals which run high in ash having a comparatively low fusing point. This is a material advantage as it permits the use of high-ash coal, which is practically valueless on account of clinkers when used on other types of grates.

The various factors enumerated in the preceding paragraphs relate primarily to efficiency. Operating records from a large number of plants show that an actual operating overall boiler efficiency of 70 per cent is difficult to maintain. This covers plants where natural draft is used and boilers are not equipped with economizers.

Limitations Governing Capacity of Stokers

The capacity is governed principally by the available draft and ratio of total boiler heating surface to the grate area. With a draft of 0.35 in. over the fire and a ratio of heating surface to grate area of 50 to 1 or less, a capacity of 170 per cent of rating should be obtained without any sacrifice in efficiency. When the ratio of heating surface to grate area is around 60 to 1, a capacity of 140 per cent rating is seldom exceeded. This is based on an available draft of 0.35 to 0.40 in. over the fire.

In many installations where the boilers are equipped for induced draft, ratings of 180 per cent to 190 per cent, and even higher, are obtained with chain grates. It is common practice to use economizers in connection with induced draft.

It has been pointed out in a number of instances that small plants burning from 50 to 150 tons of coal a day operate very economically as compared with larger plants in the same district. This is due in a large measure to the fact that the supply of coal for the small plant is obtained from one source. Under these conditions the furnace design may be changed to suit the coal used, and the most satisfactory method of operating the stokers can be determined and adhered to. The coal for the large plant, on the other hand, is secured from a number of different sources and varies materially in quality and other characteristics. This requires very close attention in order to make the numerous changes necessary in the feed, air supply, etc., to suit the different coals.

Several different makes of forced-draft link or chain-grate stokers have been placed on the market in the past few years. A number of installations of this type of stoker are to be found in the Middle West. In making provisions for furnishing air under pressure below the fuel bed, wind boxes and dampers were installed in such a way as to divide the fuel bed into several zones. The control of the air supply to any zone can be regulated independently of the other sections. This feature makes it possible to admit the air to the fuel bed where it is required, and in the proper quantity. It follows that an increased efficiency is obtained, as the excess air is reduced to a minimum. The quantity of unburned carbon in the coal is also much less than found with other types of stokers. The increased investment required by the forced-draft chain grate, however, together with the increased cost to operate, materially cuts down the saving in money due to the increased efficiency. The satisfactory operation of this type of stoker under continuous high rating and the quickness with which it responds to load requirements form a very important feature. It is possible to use coal containing a large percentage of ash which fuses at comparatively low temperatures without any difficulty on this type of stoker, and at the present time is without doubt better adapted for burning the Mid-West coals economically at high ratings than any other stoker on the market.

Underfeed forced-draft stokers in the Mid-West districts have a large number of very satisfactory operating records to their credit, both from an efficiency and a capacity standpoint. The difficulties experienced with holes burning in the fuel bed, where a thickness of 6 to 7 in. is carried, are eliminated on the underfeed. This type of stoker shares the advantage with other forced-draft stokers of being able to bring a boiler up to 250 to 300 per cent rating in a very short time. The nature and quantity of ash in the coal form probably the most important single item governing the successful operation of underfeed stokers. With a heavy fuel bed the tendency is for the ash to ball up and clinker, preventing the carbon from being burnt out in the furnace. This condition at the same time tends to interfere with the continuous operation of the stoker at

(Continued on page 561)

Organization of an Engineering Society Discussed at A.S.M.E. Spring Meeting

At the Spring Meeting Business Session there was presented a paper by Morris L. Cooke on the Organization of an Engineering Society. As the subject of this paper, which was procured by the Management Division, was of a fundamental management character, the discussion thereon was held at the Management Session.

This paper, with the discussion relating thereto, is of especial importance at this time when the revised constitution and by-laws of the Society are being presented for consideration and discussion by the membership. The draft of the new constitution and by-laws is given in Part Two of this issue in parallel form with the present constitution and also with the notes of discussion presented at the Business Session. The new constitution and by-laws will be discussed at the Annual Meeting Business Session and will be presented to the membership for letter-ballot in March.

The first discussion was presented by R. M. Gates, managing engineer of The Lakewood Engineering Company, Philadelphia, and H. V. Coes, manager of Ford Bacon & Davis, Philadelphia. These gentlemen defined the engineer as a man whose knowledge of the application of the physical laws and the technic of industries enables him to direct the use of the forces and materials of nature in anticipation of and daily solution of economic needs. Stating the purpose of the engineering society to be the promotion of the technical interest of its members, they gave the following methods of procedure:

1 Technical meetings
2 Intensified technical research
3 Bureau of technical information
4 Public representation of the engineering fraternity at large.

They classified the average society membership into two groups,—those who desire to take part in the technical work of the society, and those who are interested in engineering and in committee work relating to the promotion of engineering. The latter total possibly ten per cent of the Society membership, the balance of ninety per cent being made up of those who desire to keep in contact with their fellow-engineers and those who join under any one of a number of pretenses and who are generally indifferent.

Messrs. Gates and Coes stated the problem of society organization to be (*a*) reorganization of the method by which a society functions, and (*b*) the development of a plan to secure active participation of the indifferent members.

The discussers likened the engineering society to an organization for the production of engineering knowledge and service. They discouraged the committee idea as slow and cumbersome and presented the chart, Fig. 1, showing the proposed organization. In this chart the sales or distributing division is represented by the Local Sections activity; the production department is likened to the Professional Divisions; the administrative department to the Ways and Means Division. The duties of each of the parts of the proposed organization are listed as follows:

Professional Divisions should be required to furnish the programs, papers, discussions, research. Local Sections should advertise the professional work of the Society and arrange for local meetings. The Ways and Means Division should handle the business and operation of the Society, finance, rules, national meetings, publications, etc. Each of the groups should be directed by a vice-president of the Society. Each major sub-division of each of these groups should have a manager or chairman. These would be chairmen of our present Professional Divisions and chairman of each regional Local Section.

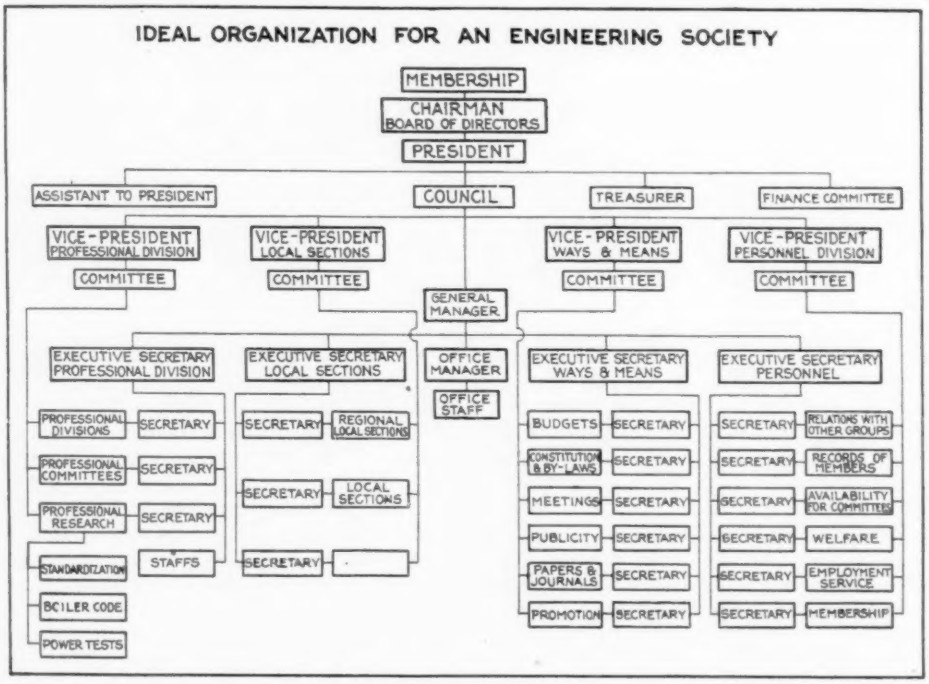


Fig. 1

The Board of Directors should consist of a president elected by the membership at large, the three preceding past presidents, a vice-president in charge of Professional Divisions elected by the Professional Divisions members, a vice-president in charge of Local Sections elected by the Local Section members, a vice-president in charge of Ways and Means Division elected by the membership at large, a vice-president in charge of Personnel elected by the membership at large, and a treasurer elected by the membership at large.

The Council as now constituted would become an advisory board without power to execute and would consist of the chairmen of the principle sub-divisions under each vice-president.

Because of the magnitude of the responsibilities of the president with the term of office only one year as under the present system, it is recommended that a general manager be employed who would be responsible for the operation of the society to the directorate through the president. This general manager should be virile, broad-gaged, able executive.

To handle the activities of the Society so that the present indifferent members will take active interest, these members should be subdivided into the following:

1 Engineers of confining work that have limited vision and a lack of ability to get acquainted
2 Men in engineering work in isolated territory whose inability to attend meetings makes them indifferent
3 Those who have become displeased over some method used by the Society or some difference of opinion.

To cope with this problem the fourth vice-president should direct membership relations with other groups, welfare, records of membership, employment and men available. His records should contain a complete report of the activities and the ability of each member. Those who are inactive should be approached either personally or through the mails, to impress upon them their responsibility in contributing to the welfare of the engineering profession. This division would afford them an avenue of approach to the professional, local or ways and means divisions of the Society, where they might assist on committees and participate in the carrying out of the Society's ideals. There are innumerable ways in which a department under such a division could be of great value to the membership of the Society.

H. J. Laski, of the School of Economics and Political Science of the University of London, presented a written discussion combining a number of valuable suggestions. Most important of these was the development within the A.S.M.E. of groups to undertake surveys of the regional problems of the country, pooling the results to obtain a catalog of the engineering needs and thus providing a basis for subsequent action. Other suggestions of Mr. Laski's called for representation of younger men on the Council, separation of policy from administration, and a setting up of a

research organization to make expert criticisms on public engineering products and to give advice to public authorities. He also suggested the study by the Society of conditions of appointment and tenure of engineering posts in the public service with constant scrutiny of such appointments and public announcement when they are unsatisfactory.

Dr. F. H. Newell, consulting engineer, Washington, D. C., emphasized two particular points brought out by Mr. Cooke as to the necessity for increasing the activity of the individual member and the need for an engineering organization to develop a method whereby the task of the engineer in an organized group can be kept abreast of the best thought of the profession and the times. In discussing the need for developing individual activity, Dr. Newell compared the activity of engineers in their regular employment and in the Society. In one case the man is impressed with his duty to deliver the goods and in the other case it is rarely brought to his attention that he has a larger duty or that it would be desirable to try to utilize the full man power of his associates, especially of the younger and newer members who may be regarded simply as an audience, or background against which may be displayed the special qualities of some leader in the profession. The traditional attitude of the Society may discourage the interest and activity of the younger men who should be attracted and inspired. Lack of opportunity for individual activity and a tendency to a conservative attitude tending to keep the control of affairs as exclusively as possible in the hands of a few men will repulse the younger man. Dr. Newell pointed out that in the case of the commercial organization the employee's interest is stimulated by compensation either in salary or in satisfaction received. The engineering society compensation must be entirely that of satisfaction received. This satisfaction may be personal contact and acquaintanceship rather than scientific or technical information. However, engineers are not sociably inclined. Dr. Newell stated that after a generation of attending engineering meetings he was not conscious of having enlarged his acquaintanceship in anything like the proportion which should have been possible. He emphasized the importance of making each member responsible for increase in membership, as there is no way of appreciating an organization better than by trying to convince another person of the benefit of belonging to it and taking part in its work. Dr. Newell also emphasized the necessity for direct appreciation of work done by officers and active members. Even though the recognition may be trivial in itself, it should still be a tangible testimonial of service rendered or skill shown.

In developing the idea that the engineering profession should be kept abreast of the times, Dr. Newell stated that papers and discussions have too often been in the nature of an autopsy of a dead issue rather than a diagnosis of real existing conditions. Live, debatable subjects will keep an organization awake and add to its efficiency. Many a responsible officer of an engineering society has urged that it would be impolitic and unwise to discuss such matters in open meeting; such discussions are the very things most needed at the present time. In closing, Dr. Newell emphasized again the necessity for showing proper appreciation of service freely given or offered by individuals or groups of less well-known members.

In an oral discussion S. N. Castle outlined the broadening of the mechanical engineer during the past thirty years with the coördinate development of the Society's organization. He emphasized the point that the Society must receive its impetus for growth from its membership but that this growth should develop effective citizenship by the better use of engineering and technical judgment. He strongly urged an effort to secure the interest of the young man entering upon an engineering career either in school or in an industry, so that his association with an engineering society will date from the time he commences his engineering studies.

Dean Perley F. Walker, of the University of Kansas, in a written discussion stated as important the present sentiment in favor of making our professional societies a more vital counterpart of the engineering profession. The public-service aspect is being broadened and should be reflected in a declaration of principles. Dr. Walker directed his discussion to the consideration of the definite situation in The American Society of Mechanical Engineers and in its connection with other organizations. He outlined briefly the aims of The Federated American Engineering Societies and explained its method of procedure. He stated the aims of our Society to be as follows:

1 To benefit the individual member as a mechanical engineer
2 To develop and perfect the profession in our own field
3 To render public service through (1) and (2), and locally through professional activities and as groups of citizens specially trained and qualified to speak on questions of civic and industrial importance.

The local-section plan seemed to Dr. Walker to be capable of most pronounced development in new lines, inasmuch as local groups are in touch with civic and local enterprises. He suggested the appointment of more local committees to do active and fruitful work in conservation of resources and materials and in the development of local power resources, in the investigation of industrial development, and in coöperation with the Chamber of Commerce. He stressed the conduct of a service publicity program and prophesied a program that would increase immeasurably the public recognition of the engineer.

L. C. Marburg, consulting engineer, New York City, divided his discussion of Mr. Cooke's paper into two parts: First, the improvement in organization and policy of any engineering society; and second, the broad question of organization of the entire profession. Under the first heading, speaking of the A.S.M.E., Mr. Marburg called attention to the small percentage of ballots returned at elections and the small number of members that "ever get into some part of the play." He called attention to the great development of local sections and the future of the professional divisions which would undoubtedly increase many times the percentage of participating members. He seconded Mr. Cooke's suggestion that some professional divisions be limited to members doing active work. Mr. Marburg emphasized the opportunity offered by the local sections for the development of majority rule in the Society. Mr. Marburg also seconded Mr. Cooke's point that the fullest publicity of Society affairs is required.

In discussing the place of the engineering society in the commercial structure, he analyzed the purposes for which engineers are organized as scientific or technical and public. The public aims of the society are the attempts to render the service of the group to the community and incidentally to secure public recognition for the group. To successfully develop these aims, Mr. Marburg stated the need for an all-inclusive organization, as its influence would be in proportion to its size. He sounded a solemn warning that the engineers would lose their influence upon obtaining the reputation of being a set of highbrows. He pictured the difficulty of the adoption of an ideal type of organization because of the impossibility of realizing such a type in view of previous developments. Mr. Marburg reiterated as the most important statement of Mr. Cooke's that no organization of the profession will be satisfactory which does not provide for the greatest coöperation with other groups. Although a number of public problems today are in a large part engineering there are still other public problems which require the services of a group of experts for solution and it is with such groups that engineering coöperation must be played up. In closing Mr. Marburg emphasized again that the great opportunity which the engineering profession has for gaining influence by developing the ideal of service.

Mr. Cooke's Closure to the Discussion

Before the administrative and managerial problems of the profession and of the various organizations through which it functions can be profitably discussed, every effort must be made to visualize the enlarging field of the engineer. If one can get a sense of the desired crop, seed, soil and season become measurably fixed. Method is by no means negligible. But it is of the very first importance to decide on the goal towards which to strive. Otherwise united effort is impossible and even the strong press forward less ably than they would if the common objectives were fully determined.

There are many reasons for believing that as a group we are timorous in acknowledging the high purpose to which we are in-

vited through our education and experience and ability. Somehow we must learn to rise above the weakness inherent in our capacity for specialization. If possible, we must pay even greater tribute to the individual who through painstaking and unremitting toil digs out the true inwardness of a set of baffling facts. But also we must more and more insist that the completed task include the the relating of the result of our research to that whole scheme of living for the betterment of which the engineer is, we hope, becoming the master-architect.

So in all our planning as to method we should not only always have our objectives in mind, but keep them fluid so as to be capable of easy adjustment to meet the rising standards of action within the profession and changing needs without.

Any author would be pleased with the quantity and kind of discussion which this paper has received. Nevertheless it is a bit disappointing that so little of it suggests that to the engineer belongs the task of formulating definite programs "of creation and of construction, of stimulation of human effort and accomplishment." We should abandon the theory that we are assisting some other agency such as government or society. Both the responsibility and opportunity are wholly ours—are being literally forced upon us—almost literally in its totality.

With the task so defined the outstanding change called for is to get a larger number of members of the profession actually at our group work. The suggestion of Messrs. Coes and Gates for a personnel secretary seems altogether convincing. Such an official would only indirectly be interested in projects. His concern would be the maximum number of members making some contribution to the total volume of work. Then all through the formal and informal discussion of the paper has been emphasized the necessity for getting the young men both into the Society and at work as early as possible. If any one doubts how much this is needed and demanded, let him make a trip around the country visiting engineering organizations.

No such study as this can be altogether frank or very helpful without a suggestion as to one major danger which at every turn casts at least a shadow across our path, i.e., the influence of business as contrasted with engineering considerations. Because of this we must constantly make excuses both for things done and things left undone. No other profession in its development is quite so beset. We must constantly study the technique of steering clear of these influences and dangers and so set ourselves free to work at full liberty at our appointed task.

Vernon Kellogg says that while "the biologist does have certain positive knowledge of some conditions or factors that do help to determine the course of human life," it is also true that "the course of human life is partly determined by a set of conditions which are, so far, at least quite outside the special knowledge of the biologist. He can guess and wonder about them, just as other people do, but he has no right to claim that he knows about them." And so we engineers would rarely give people cause for offense if in our discussions we could frankly separate those matters which we have reasonably positive knowledge from those in which our judgment is no better than that of other well-opinioned folk.

In the end the machinery of administration and management will adjust itself to the ambitions and environment of the profession. The largest contributions to a better organization for the group will come from those engineers who, while insisting that as individuals we shall be afforded conditions most advantageous for good work, make effective public service the final test of our success.

Analysis of the positions held by the graduates of engineering colleges shows that only fifteen to eighteen per cent stay in technical work. The major portion enter widely different pursuits, although many seek positions of executive or managerial responsibility. This situation and the need of industry for trained intelligence to direct and operate its complex activities, has caused a number of engineering schools to establish new courses to educate executives. The Society of Industrial Engineers has also planned such a course. Prof. Collins P. Bliss, of New York University, has compared eight of these courses, and in an extended article in the July issue of *Managememt Engineering* shows their make-up and gives the time allotted to each general group of subjects and to each study.

GRAPHICS IN BUSINESS

That over 40 per cent of the members of The American Society of Mechanical Engineers are engaged in executive and administrative work is an indication that business requires its leaders to possess qualities which are developed by engineering training and experience. The demand is greater than ever for executives well trained in the analysis and evaluation of forces and influences that affect business. With its growth in complexity business is demanding a better knowledge of its significant facts. Much of the executive's time and effort is spent in the maintenance of a proper balance among the various activities and influencing factors of his enterprise. Stimulation of some and checking of others to meet the ever-changing requirements, call for numerous and frequent comparisons of these factors on which to base judgments and decisions.

The progressive executive realizes the necessity for improved methods for getting at the facts and for performing his own work. To an increasing degree he is seeking the aid of scientific methods to lighten his burden. Accounting and statistical reports have been used extensively to convey to him the facts of his enterprise, but these leave largely to him the burden of interpreting the figures in terms of relative movements of the various factors they represent. This requires him to retain in his memory large quantities of figures or to spend much valuable time in study and reference to tables and detailed data if he is to have a comprehensive knowledge of his intricate undertaking. Frequently he is forced to resort to short-cut formulas, often unsound, as a means of freeing his mind.

The presentation of the facts of the enterprise in vivid picture form, so that the interrelations and movements are quickly grasped and easily retained, is the function of modern business graphics. The relations and movements are the significant things to the executive, much more so than the absolute values of the different factors at any given time. The weakness of accounting and statistical presentations as distinguished from the graphic method lies in their static quality and the difficulty of conveying by figures an adequate conception of movement and interrelation. Considerable mental effort is required to obtain from a table of figures a clear conception of the direction and magnitude of the movement, for example, of the volume of sales of a product over a period of twelve months. A clearer mental picture can be quickly obtained without effort from a properly designed graph based on the same figures. When, however, it is desired to show the relations of these movements to those of similar previous periods or to predetermined quotas, the contrast between the use of tables and of a coördinated series of charts is vastly greater. Contact of executives with the earlier efforts to utilize graphic charts has lead many to view them with skepticism and not without reason. Frequently such charts were designed without any apparent regard for their comparability one with another, and as much study was required for their interpretation as for the corresponding tables. Study of these earlier efforts, from the viewpoint of executive needs with a realization of the importance of comparability of the charts in a given enterprise, has led to the development of a technique of chart construction which has greatly simplified their use. Many progressive concerns have appreciated the time-saving value of coördinated graphs as a management tool for the control of their activities.

Concurrent with the development of standardization in the construction of business charts has come a marked reduction in the cost of their production—an important factor when large numbers are used. While formerly it required men of considerable engineering and statistical ability to prepare reliable and practical business-control charts, it is now possible, by the employment of standard methods, inexpensive equipments and limited instructions, to prepare them with lower-paid clerks and stenographers and with great rapidity.

The "fact" type of mind is responsible for the perfection of this tool of business, and as the engineer becomes more familiar with fields of business and finance into which he is being drawn, there is every prospect that equally satisfactory solutions will be found for the many other problems such activities present.

W. Herman Greul.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Straight-Flow High-Lift Poppet-Valve Steam Engine

By J. Stumpf

Losses in steam engines are due to cylinder condensation, clearance space, throttling, friction, leakage, heat radiation, heat conduction and imperfect expansion. It is claimed that some of these losses are reduced in the engine about to be described.

The most characteristic element in this straight-flow or "uniflow" steam-engine cylinder shown in Fig. 1 is the very small high-lift nozzle-disk valve employed therein. It became possible to give this valve such small dimensions through the employment of a valve-gear shaft running at twice the speed of the main engine shaft. For an average cut-off of 10 per cent the eccentric motion with the camshaft running at a speed of the main shaft will give a maximum valve lift of h', while a valve lift h four times as great is obtained with a double speed of rotation by means of which the central angle α is increased to 2α. Because of this a double-seated valve of 200 mm. (7.87 in.) diameter can be replaced by a disk valve 100 mm. (3.93 in.) in diameter, with a corresponding reduction of clearance space and cylinder condensation area.

The valve motion is regulated from a layshaft running at twice the speed of the engine shaft by means of a cam, of which the lift and lead are regulated by means of a shaft governor, Fig. 3. The

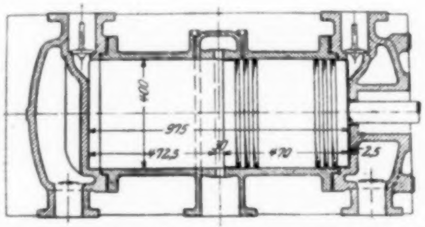


Fig. 1 Straight-Flow Steam Engine with the New Stumpf High-Lift Nozzle-Disk Valve

motion of the eccentric is transmitted to the disk valve by means of an intermediate lever and an angular lever located in the casing. The intermediate lever is made up in the form of an eccentric ring set on a rigid eccentric disk running at the same speed as the main engine shaft. The arrangement is such that when the main eccentric takes the position corresponding to the maximum valve lift

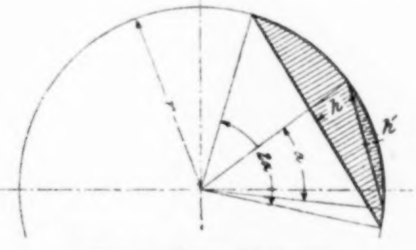


Fig. 2 Valve Diagrams

the auxiliary eccentric on the second lay shaft is in the opposite extreme position, thus producing an increased valve lift. When the main eccentric occupies the next similar position, the auxiliary eccentric reaches the opposite location so that the actions of the two eccentrics have to be subtracted from each other. The resultant valve motions are shown again in Fig. 4 by means of the Zeuner polar diagram, which emphasizes the extent of the valve opening resulting from the fact that the valve lay shaft runs at twice the speed of the main engine, and also shows the absence of all necessary motion of the valve in the opposite position. The linear lead remains the same. As a result of this arrangement it becomes possible to use small valves with a total clearance in the cylinder of between $^3/_4$ and 1 per cent and with an extremely small area of cylinder condensation surfaces. If it be assumed

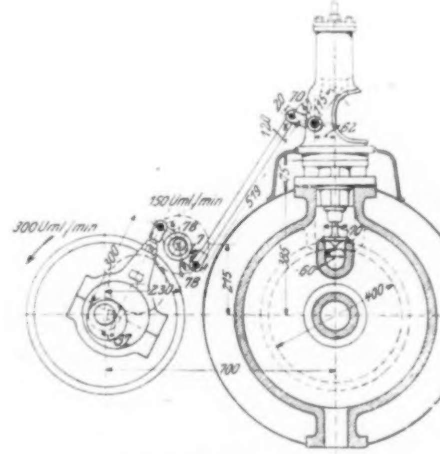


Fig. 3 Valve-Gear Drive

that these condensation surfaces are ideally small, that is, equal to twice the cross-section of the cylinder, it would appear that the additional cylinder condensation surface entailed by the use of the small high-lift nozzle-disk valve is only from 3 to 5 per cent thereof. It is claimed that this arrangement affects the reduction of cylinder condensation area in a most favorable manner, which

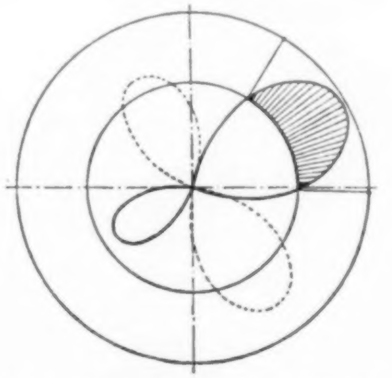


Fig. 4 Zeuner Polar Valve Diagram

is generally low in straight-flow steam engines. As regards this latter, reference is made to tests carried out on a straight-flow cylinder by Professor Nagel at the Dresden Polytechnic Institute. (The temperature diagram of these tests is reproduced in Fig. 5.) In that case only the cylinder head was provided with a jacket and the engine was operated with an extremely good vacuum. Notwithstanding this fact, during the exhaust stroke the temperature, as determined by a thermometer in the head, did not fall below 100 deg. cent. Because of the extensive temperature drop during the exhaust and because of the appearance of a very considerable percentage of moisture in the steam (as high as 20 per cent), the heat of the steam in the head was caused to flow with great energy into the rest of the steam still present in the cylinder. Of this heat practically none is lost in the exhaust. The piston

on its return stroke collects this overflow of heat by the compression of the remainder of steam to something like 2.5 to 3 atmos., corresponding to a clearance of about 3.3 per cent. The next compression occurs practically along the saturation adiabatic curve, which is joined at an angle by the superheat adiabatic curve and gives the startlingly high compression and temperature of 510 deg. cent. At the end of the admission the superheat expansion adiabatic curve joins on, and then abruptly the saturation adiabatic curve. This latter, in its last stages, is raised by the setting up of the flow of heat referred to above until the exhaust again causes temperature drop, which is, however, immediately opposed by the flow of heat from the cylinder-head steam.

However, when, by the use of the high-lift nozzle-disk valve

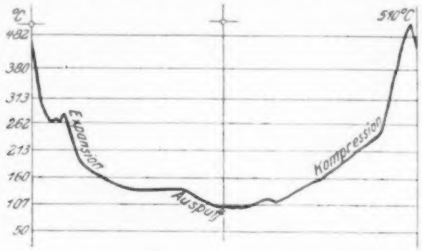


Fig. 5 Temperature Diagram
(*Auspuff* = exhaust)

the clearance is reduced from 3.3 per cent to something between 3/4 and 1 per cent, the compression end pressure is raised correspondingly, resulting in a rise of compression and temperature of between 900 and 1000 deg. cent. In this connection Professor Nagel has established the surprising fact that in the same manner a final compression temperature with saturated steam is obtained

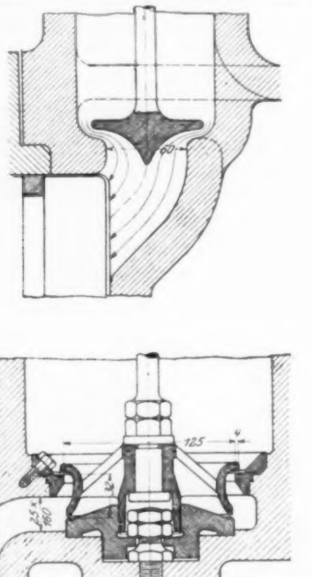


Fig. 6 Comparison of Two Kinds of Engine Valves with Same Area of Steam Passage: Above, High-Lift Nozzle-Disk Valve; Below, Double-Seated Valve

100 deg. cent. higher than with superheated steam, which is probably attributable to the higher heat conductivity of saturated steam.

If, however, these favorable heat conditions are combined with small cylinder condensation surfaces as becomes possible with the new high-lift nozzle-disk valve, it may be ultimately possible to do away with cylinder condensation entirely.

The upper part of Fig. 6 shows the new high-lift nozzle-disk valve operated by a lay shaft running at twice the speed of the main shaft, as compared with the double-seated valve of standard design below it, and also their relative dimensions. It is also claimed that the new valve is considerably simpler and cheaper both in manufacture and in installation. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 19, May 7, 1921, pp. 492–494, 7 figs., *d.*)

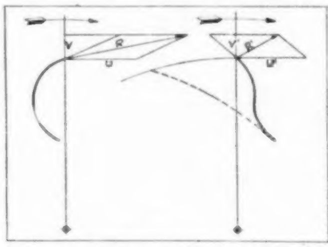
Short Abstracts of the Month

AIR MACHINERY

Centrifugal-Fan Design

Some Developments in Centrifugal-Fan Design, F. W. Bailey and A. A. Criqui. The authors claim that when multiblade forward-curved-blade fans supplanted the older type of straight radial-blade fans, two very good characteristics of the old blade fans were lost. One of these was the pressure curve which rose continuously with the decrease in capacity, and the other was the power curve which increased constantly with increasing capacity. In the forward-curved-blade fan the pressure curve drops or flattens with decreasing capacity within the working range of the fan, while the power curve has a more abrupt rise as the load increases, a combination which sometimes causes serious trouble in fan installations. The flat portion of the pressure curve makes the fan very sensitive to resistance variations, and if used at a capacity corresponding to this portion of the curve may make the fan run under or over the estimated capacity. This is particularly so if the friction of the system is slightly greater or less than was estimated or if an existing duct system is changed with the consequent change in resistance.

With a directly connected unit, when a fan which has an abruptly rising power curve runs above the estimated capacity, there is a decided danger of overloading the motor. With a motor-driven forward-curved-blade fan run at this critical point in its range, it is necessary to supply an excess of motor power with a probability of running the motor at reduced capacity and therefore reduced efficiency to guard against the possibility of the fan overloading. This represents a perpetual insurance payment when using a forward-curved-blade fan under these conditions. The flat or droop-



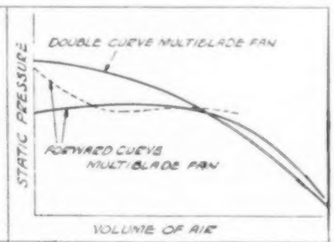


Fig. 1 Fig. 2

Fig. 1 Comparison of the Forward-Curved and the Backward-Curved Designs of Blades for Centrifugal Fans

Fig. 2 Comparison of Pressure Curves of the Forward and Double-Curved-Blade Types of Fans

ing portion of the pressure curve also causes trouble in double-width fans, or when two single fans blow into the same duct system, provided that the capacity comes within the range of this flat portion of the curve. If there is some difference in the resistance at the two inlets, which frequently happens, the capacity of one wheel will be reduced without any corresponding increase in pressure and this wheel then has no power within itself to regain the load, with the result that sometimes air will go in only one inlet of a double-width fan and the other wheel will merely churn the air in and out of its inlet.

A desirable combination of fan characteristics would be to retain the good features of the old radial-blade fan and at the same time have the high capacity range, insuring a small housing, together with the higher efficiency of the forward-curved-blade fan. During the past few years a new type of multi-blade fan has been developed which is said to combine these good features. This fan has blades which curve forward at the heel to meet the incoming air, but curve backward at the tip to discharge the air. Thus, while the blade of the forward-curved fan is a portion of the surface of one cylinder or one cone, the blade of the new backward-curved blade is formed from the surfaces of two cylinders or two cones, as shown in Fig. 1.

Fig. 2 shows the comparative pressure curves of a forward- and double-curved-blade fan. The latter has the continuous rising pressure curve, which, when capacity decreases, builds up a pressure to overcome the added resistance. In double-width fan, when one inlet is more restricted than the other, the tendency is for less air to flow through that inlet. In such a case the restricted wheel will build up a pressure to meet the added resistance and will thus retain its share of the load. As a result, a double-width fan of the double-curved-blade type will divide the load between the two wheels throughout the whole range of capacities and neither of the parts will simply churn the air as in the forward-curved-blade type.

The original article gives also curves showing the comparative static efficiencies of forward- and double-curved-blade fans and a comparison of their power curves.

The two types are not always competing. The forward-curved multi-blade fan is preferred where very high outlet velocity is required and noise is not objectionable. On the other hand, the double-curved multi-blade fan is essentially the medium-capacity fan and lends itself particularly to that class of ventilating work where very high outlet velocities are not needed or desirable; at the same time it is decidedly a higher-capacity fan than was the old radial-blade fan.

Double-curved multi-blade fans are inherently higher-speed fans than are those with forward-curved blades and this brings up the question of specifications. With the advent of the forward-curved-blade trouble was experienced from noisy fans, which was attributed to the higher speeds at which these fans ran. Engineers and architects therefore got the habit of writing into their specifications clauses which limited the speeds of multi-blade fans in order to insure large sizes or relatively slow-speed makes. As a matter of fact, the noise had very little to do with the speed of the fan. Double-curved-blade fans do not cause as much noise and at the same time must be run at high speeds. Therefore specifications which fix low speeds would practically prohibit the use of double-curved-blade fans. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 27, no. 4, May 1921, pp. 375–380, 7 figs., *pc*)

BUREAU OF STANDARDS (See Engineering Materials)

CORROSION (See Machine Parts)

ENGINEERING MATERIALS (See also Machine Parts)

Theory of Hardening of Metals

The Slip-Interference Theory of the Hardening of Metals, Zay Jeffries and R. S. Archer. The authors define hardness as resistance to permanent deformation. Metals owe their hardness and strength to the attractive forces between their atoms. Metals, however, are also crystalline and are built up of atoms arranged in definite and repeating patterns. The regularity of the atomic arrangements gives rise to certain planes of weakness or low resistance to shearing stress.

When an external load produces on such a plane a shearing stress which exceeds the resistance of the crystal to shear on that particular plane, fracture of the crystal takes place. Fragments formed may or may not adhere to each other. If they do not the failure of the crystal is complete and it is said to be brittle, the plane of weakness being then known as the "cleavage plane." In the useful metals, more generally, the crystal fragments adhere and merely glide or "slip" over each other. In such a case the planes of weakness are called "slip planes."

Anything that serves to hinder slip is a source of strength and hardness. The hardening and strength of metals may be considered as due principally to interference with slip.

The authors express the relation between grain size and strength for pure metals by stating that the most simple source of increased hardness is grain refinement, which introduces slip interference at the grain boundaries due to the different orientations of the adjacent grains and especially in fine-grained metals to the disorganized or amorphous metal between the grains.

This theory is applied to the aging of duralumin, with respect to which the authors arrive at the conclusion that there is a certain average size of particle which produces maximum hardness, any size either larger or smaller causing less hardness. This is opposed to the generally held idea that a given amount of substance added to a metal produces the greatest possible hardening effect when it is in solution, that is, when it is in the highest possible state of dispersion.

The paper is too extensive to permit of making a complete abstract, and the following is taken from the summary prepared by the authors themselves:

Cold-working introduces slip interference by the fragmentation of the grains and the production of amorphous metal.

The hardness and strength of amorphous metal itself are due to the absence of the planes of weakness characteristic of crystals.

Slip within grains is opposed by the presence of a strong constituent at the grain boundary, provided that if the strong constituent is brittle, its shape and size are not such as to lead to effective weakness due to eccentricity of loading.

Effective hardening is obtained by slip interference within the grains, due to the presence of hard constituents uniformly distributed in the form of very fine particles.

It is not necessary that the hard constituent possess great adhesion for the matrix.

The effect of a given amount of hard constituent increases with the fineness of subdivision, reaching a maximum at an average particle size denoted by the term "critical dispersion." The critical dispersion probably consists of the smallest particles having the characteristic properties of the crystalline substance.

The order of magnitude of the diameter of such particles is probably about 10^{-7} cm. A higher degree of dispersion, particularly the atomic dispersion of solid solutions, is less conducive to hardness.

Corresponding to the maximum hardness at critical dispersion, there is a minimum in ductility.

Increase in the amount of dispersed substance produces increased hardness, but the brittleness also increases, so that there is a limit to the useful hardness and strength that can be obtained.

The amount of hard dispersed substance which produces the greatest useful strength increases as the size of particle increases.

The actual amounts of hard dispersed substances which produce useful results are from about 2 to 15 per cent by volume.

The only manner in which the high degrees of dispersion desired are produced consists in the limited decomposition of solutions, and in particular of solid solutions.

Martensite consists of a solid solution of carbon in very fine-grained alpha iron. The hardness is due chiefly to the grain refinement of the ferrite, but partly to the carbon in solution.

The tempering of martensite involves two changes: ferrite grain growth and the precipitation and growth of cementite particles. Ferrite grain growth causes progressive softening. The precipitation of cementite causes hardening, but the growth of the particles above the critical size produces softening. (*Chemical and Metallurgical Engineering*, vol. 24, no. 24, June 15, 1921, pp. 1057–1067, 11 figs., *tA*)

Wood-Reinforced Concrete

Concrete Reinforced with Wood, M. Levatel. Shortage and at times complete lack of steel during the war has given an impetus toward the use of concrete and, concurrently, a method for reinforcing concrete with non-metallic materials. The Italian engineer, Mario Viscardini, in the early part of 1918 produced concrete beams reinforced with wooden lattice work. Tests on these beams have shown that in general they behave practically in the same manner as similar beams reinforced with steel, but, of course, the numerical values of elastic limit and total strength are different. If wood-reinforced beams are overloaded they begin to crack, the cracks being larger and more clearly defined than in the case of steel-reinforced beams, but like the latter they can be easily repaired provided the stress did not exceed the elastic limit.

The same results have been obtained in tests made by Von Emperger and an Austrian commission, who have carried out an extensive

series of tests on wood-reinforced concrete beams and have found that the ratio of coefficients of elasticity of concrete and wood may be practically taken as unity.

One of the difficulties with wood reinforcement lay in the fact that in the first place the reinforcing elements had to be straight, and in the second place the stirrups could not be counted on to increase the adhesion between the concrete and the reinforcing elements. Among other things, it was found that tarring the wood reinforcing elements reduced the adhesion, whereas a wash of lime or cement, and in particular magnesia cement, over the wood reinforcing elements apparently increased the adhesion. Further tests by the Austrian commission have also shown that the proportion of wood to the total section of the beam should

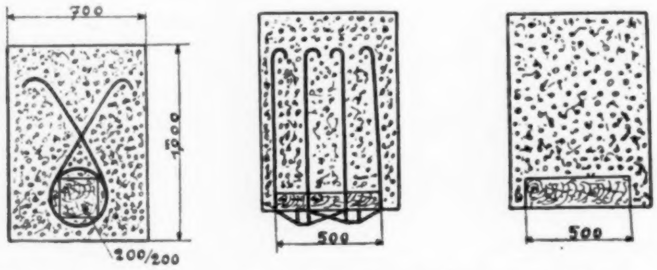


FIG. 3 DISTRIBUTION OF WOOD REINFORCING ELEMENTS IN CONCRETE BEAMS RECOMMENDED BY AN AUSTRIAN COMMISSION

not exceed a certain percentage. In particular, beams of sections such as shown in Fig. 3 proved to be best.

In Germany a beam has been developed employing both steel and wood reinforcing elements (Fig. 4). In this the reinforcements which are in tension are of steel and those in compression are of wood, the latter being placed so that they form the top of the

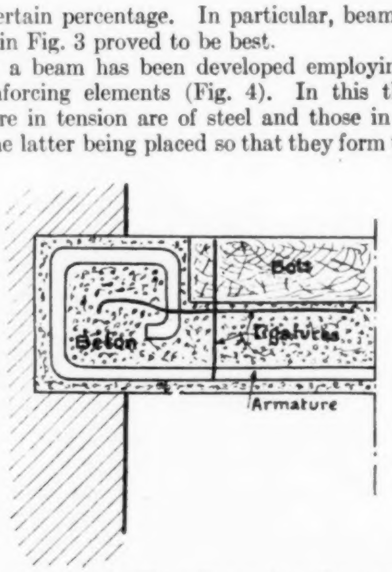


FIG. 4 GERMAN STEEL-WOOD REINFORCED-CONCRETE BEAM
(*Beton*, concrete; *Bois*, wood; *Armature*, steel reinforcement; *Ligatures*, tie pieces.)

beam and may be used for attaching boards, etc. Theoretically such a construction is complicated but it may have practical advantages.

One of the most interesting applications of wood-reinforced concrete has been made in the construction of the steamer *Linnea* in Sweden. This is a 700-ton vessel built essentially with the framework of an ordinary wooden ship and having concrete applied over it. The vessel has been in service on the Baltic and has apparently given satisfaction. (The original article describes an interesting method for launching it as concrete vessels cannot be conveniently launched with the usual gear.) (*L'Outillage*, vol. 198, no. 10, Mar. 10, 1921, pp. 283–284, 10 figs., *d*)

TESTS OF NEW CONCRETE PRESSURE PIPE. Description of tests recently carried out at Cleveland on a new type of reinforced-concrete pipe designed to withstand a pressure of 115 lb. per sq. in. (Failed at 255 lb. to the sq. in.) The chief feature of the design of the pipe is a longitudinally welded steel cylinder carrying a wire reinforcing mesh on the inside and outside, the whole being encased in concrete. The reinforcement is locked to the cylinder by strips of metal welded to its inside and outside faces. The ends of the steel cylinder are welded to sheet-metal hoops so formed as to take care of the expansion and contraction during the life of the pipe. The ends of the pipe are formed into the bell-and-spigot type, the sheet-metal hoops coming together in laying to form a lap joint on a bevel.

The pipe used in this test consisted of a steel cylinder 42 in. long, and 40 in. in diameter. Seven steel ribs $^5/_8$ in. by $^3/_{16}$ in. were equally spaced on the outside and inside of the cylinder and spot-welded to hold them upright. These ribs were punched with $^1/_2$-in. holes on $^3/_4$-in. centers to give a good bond with the concrete. They also acted as spacers for the reinforcing wire mesh.

The pipe was poured in steel forms from a rather wet mixture of Universal portland cement, roofing gravel with a density of 115 lb. per cu ft. and Pelee Island sand of a uniformity coefficient of 2.18 and an effective size of 0.22 mm. A mix of one part of cement, two parts of sand and four parts of gravel by volume was used.

In making the internal-hydraulic-pressure test, pressure was applied by means of a boiler test pump. At a pressure of 230 lb. per sq. in. horizontal cracks appeared in the two end sections. At 255 lb. per sq. in. a break occurred in one of the pipes. The rupture was directly caused by the failure of a large portion of the longitudinal lap weld which extended through the length of the main cylinder. In breaking, the concrete on both the inside and outside of the pipe was shattered.

An external pressure test was also applied in accordance with the method outlined by the American Society for Testing Materials.

From these tests it would appear that the wire-mesh reinforcing may be assigned a portion of the stress, perhaps the greater part of it, in which case it would seem advisable to increase the thickness of the concrete on the outside of the pipe and space the wire mesh at a somewhat greater distance from the steel cylinder. (*Concrete*, vol. 18, no. 5, May 1921, pp. 242–244, 4 figs., *de*)

SOME FACTORS AFFECTING THE LIFE OF MACHINE-GUN BARRELS, W. W. Sveshnikoff. The star-gage measurements made on six machine-gun barrels at various stages of firing indicate that when the life limit is reached, exhaustion is due to a combination of the abrasive action of the bullet and the abrasion by hot gases.

The author's experiments using the electric arc show that the rapid cooling (which is due to the large mass of cold metal near the highly heated inner surface of the steel) from temperatures near the melting point of the metal produces a martensitic layer. A similar layer is produced in firing a machine gun, indicating that the temperature conditions for development of martensite by the electric arc are similar to those in the gun under actual fire.

The selective hardening of the steel sets up surface strains, and the surface of the bore is readily cracked on account of the dimensional changes of the hardened brittle surface of the steel resulting from sudden changes in temperature between separate shots. The cracks originate at irregularities in the surface of the bore, attributable to the method of manufacture of the barrels. (*Abstract of Technologic Paper of the Bureau of Standards*, No. 191, *e*)

COMPARATIVE TESTS OF STEELS AT HIGH TEMPERATURE, R. S. MacPherran. Data of tests made in the laboratory of the Allis-Chalmers Manufacturing Company to determine the comparative properties of various steels at high temperatures. The work was undertaken with the view to obtaining information as to the best material for use under operating conditions of 600 to 1000 deg. fahr.

Measurements were made with an electrically heated box in which the pyrometer head was practically in contact with the center of the test specimen. It was found that there is no one temperature at which all steels show a decided change in physical properties and that this point varies with the composition and treatment of the steel.

The maximum tensile strength for rolled carbon steel annealed,

and forged 3.25 per cent nickel steel annealed, occurs at about 600 and 650 deg. fahr.

The majority of the tensile-strength curves, especially those of heat-treated steels, drop sharply as the temperature exceeds 800 deg. fahr. The effect of nickel in small amounts is slight, but in large percentages it tends to lower the temperature at which tensile strength begins to decline. Nickel steel is the only steel examined where the ductility materially diminishes at the higher temperatures, monel metal bars, it is to be noted, however, behaving in the same manner.

Alloy steels containing chromium are less affected by rise in temperature than carbon steels, and it has been generally found that apparently the introduction of metals forming carbides tends to strengthen steels at high temperatures.

This, to a certain extent, bears out the results of tests on the comparative retention of physical properties in alloy steels at 1200 deg. fahr. or over by Leslie Aitchison, who finds the order of value to be tungsten, high-chromium and 3 per cent nickel. (Paper read at the meeting of the American Society for Testing Materials, June 24, 1921, abstracted through *Chemical and Metallurgical Engineering*, vol. 54, no. 26, June 29, 1921, pp. 1153–1155, 13 figs., *eA*)

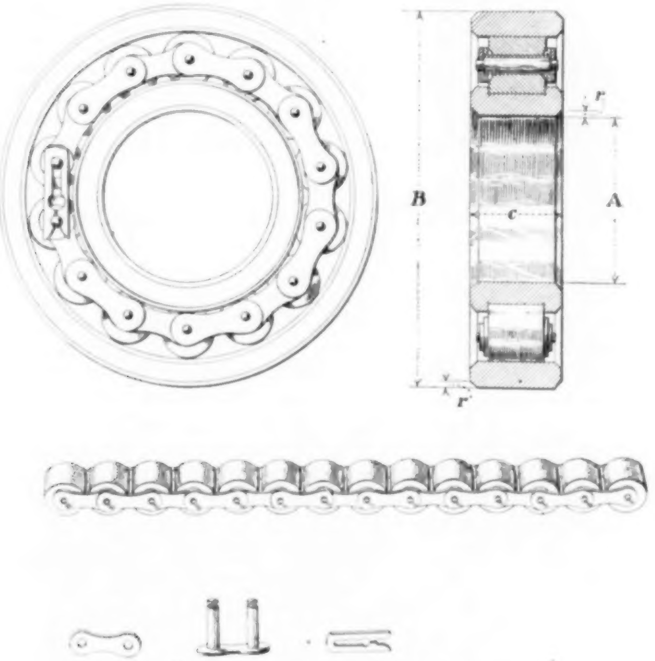


Fig. 5 Chain Roller Bearing

FUELS AND FIRING

A New Engine Fuel. At the meeting of the Society of German Chemists recently held at Stuttgart, Doctor Schrauth of the University of Berlin announced the development of a new fuel derived from naphthalene.

Naphthalene was used as a fuel even before the war, but the difficulty with it is that it is solid at ordinary temperatures and therefore requires preheating devices. It appears that now it has been converted into a liquid compound, tetrahydronaphthalene, having its boiling point at 205 deg. cent. (401 deg. fahr.) and a flash point of 78 deg. cent. (172.4 deg. fahr.) with the heating value of 11,600 calories per kilogram (20,880 B.t.u. per lb.), which makes it very desirable for high-compression engines of the aviation type. In ordinary automobile engines it can be used by mixing with materials boiling at lower temperatures such as gasoline—preferably in the proportion of one to one. Benzol may also be used instead of gasoline. It is stated that the new material, which, for the sake of brevity, is referred to as tetraline, has also a high dissolving power and can be used as a cleaning agent instead of gasoline. In this respect its low inflammability is of particular value. (*Aeronautics*, vol. 20, no. 398, June 2, p. 391, *g*)

INTERNAL - COMBUSTION ENGINEERING (See Fuels and Firing)

MACHINE ELEMENTS

Chain Roller Bearing. Description of a new bearing placed on the market about a year ago by a British company.

The principal feature of the bearing (Fig. 5) is the employment of an endless and detachable chain as a separating and guiding means for the rollers. This gives certain advantages. Thus, the maximum number of rollers of the largest possible diameter are employed in each bearing, because the chain cage allows the rollers the minimum margin of clearance between one another without permitting them to come in contact; this eliminates separating pieces between the rollers and thereby provides an increased load-carrying capacity.

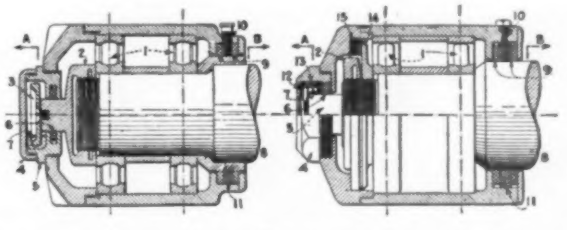
Each chain has a detachable link with spring-fastening clip which allows the chain to be unwrapped from the inner race for inspection, cleaning or replacement. This is an important feature with large drums where a standard pitch of chain cage of any length with any size of rollers can be simply wrapped around the drum without any special cage being required. (*The Practical Engineer*, vol. 63, no. 1788, June 2, 1921, pp. 347–348. 1 fig., *d*)

MACHINE PARTS

Ball Bearings on Electric Cars

Destructive Effect of Current on Ball Bearings of Electric Cars, Hilding Angstrom. Ball bearings on electric cars, in addition to great mechanical stresses, are also subjected to the destructive influences of current. The present paper (the author of which is connected with the Engineering Department of the Tramway System in Malmo, Sweden) is based on tests made by the General Electric Company and the Union Aktien-Gesellschaft, as well as on European practice.

From these tests it appears that a current as low as one ampere per square inch corrodes the housings and that a much smaller current is sufficient to damage the bearing metal. This is partly due to the fact that with ball bearings there is an almost metallic contact between the parts and no film of insulating oil intervenes.



Figs. 6 and 7 Journal Boxes Fitted with Auxiliary Contacts for Carrying Current

Fig. 6 At Left, Double Nut Arrangement

Fig. 7 At Right, Additional Pressure Provided by Spring

The flow of current from the trolley wheel downward is such that the various motor bearings and the gearing are in the path of the current with the ground. The action of the current is partly chemical but largely of the character of a weld, and it is chiefly the rupturing effect of the current that produces the welding action on the balls.

Figures in the original article show balls and bearings which have been thus destroyed. Of particular interest are dark stains on the balls which appear in the photographs. These were formerly considered as having been caused by acid in the lubricant or by shelling through fatigue.

Additional experiments have shown that the current distribution among the balls depends to a large extent on the load placed on them and that it is the rupturing effect and not the permanent current due to metallic contact that has the most damaging influence on their durability.

To prevent damage to the balls through the passage of electric

current some form of shunting device should be applied. The insulation of the outer ring of the ball bearing is possible but does not appear practical, as the repeated blows and shocks to which ball bearings are subjected would probably rupture or at least compress the insulating material and this would then produce additional stress in the ball bearings. A better way is to place a shunt or auxiliary contact arrangement outside of the ball- and roller-bearing casing. This shunt should have such a low resistance that it would practically exclude all transmission of current through the balls or the rollers.

A journal box fitted with N.K.A. disk bearings is shown in Fig. 7. This type of bearing has rollers which are self-centering, so that they tend to adjust their axis of rotation parallel to the axle of the wheel. The right-hand sides of the bearings shown in Figs. 6 and 7, which are marked *B*, show a current-transmission arrangement that can be applied to new bearing boxes. This arrangement consists of two brass rings which bear against the collar of the wheel axle. These brass rings also serve to support the felt rings 9, against which they are pressed by means of a spring. To provide a better contact and a path of less resistance for the current, the space between the brass rings is filled with graphite or mercury. The conducting power of graphite is about 10^{14} times as great as that of oil, and it is thus evident that the use of graphite facilitates the transmission of current to a high degree. This type of box provides a path of low resistance for the current and at the same time gives a very tight construction against the entrance of sand or dust from the outside. The left-hand ends of Figs. 6 and 7 marked *A* show a contact nut arrangement which can be applied to old ball- or roller-bearing boxes. In general this type of construction corresponds to that just described. In Fig. 6-*A* the current passes through the double nut at 4 and 5 to the graphite or mercury layer 7 and then to the contact disks 3, contact pin 2, and then to the axle of the wheel. In Fig. 7 *A* the nut arrangement is simplified somewhat and the tightening ring has been made more effective by the use of a spring bearing on a brass contact disk 7. The path of the current in this construction is through the contact nut 4, the contact spring 12 and the contact disk 7 to the contact pin 5 and then to the axle of the wheel. (*Electric Railway Journal*, vol. 57, no. 21, May 21, 1921, p. 941–944, 13 figs., *te*)

MACHINE SHOP

Cold Swaging

Cold Swaging. Swaging is used for work having a circular cross-sectional area and metal cannot be swaged by a swaging machine into any other sectional shape. Swaging is used mainly for producing small wire parts, sewing needles and instrument parts, and for tapering and reducing the diameter of tubing. [It may be added that swaging is also used in certain metallurgical processes as, for example, in the production of malleable tungsten wire by the Coolidge process—Editor.]

The article describes in particular the Dayton swaging machine which has a spindle speed of 300 r.p.m. and gives an average of 3600 quick short blows each minute.

Swaging increases the strength of materials, as has been shown by tests conducted in the physical laboratory of the Torrington Co. In six tests made there on cold-drawn steel wire ranging in diameter from 0.175 to 0.467 in. it was found that in all cases the tensile strength of the wire was increased by swaging and that the greatest gain in tensile strength occurred in the wire of the least strength before swaging. Furthermore, it does not appear that swaging affects unfavorably resilience or ductility of the material.

One of the most important applications of the swaging process is the reduction in diameter and tapering of tubes. Fire-hose nozzles and bicycle-frame parts in larger sizes and metal pencil shells and lightning-rod ends in smaller sizes are handled in this way. Swaging is also used in jewelry work and it is the only known process by which a gold-plated base-metal ingot may be reduced in diameter and still produce a plated article which will successfully withstand the acid test. It is stated that when a sample of wire of the sizes used in optical and jewelry trades is fractured and examined, the protective covering is so thin that there is no visible indication of an existing plate. On the other hand, case-hardened steel cannot be swaged as the hardened case fractures and crumbles.

Screw threads may be produced by swaging, the wire passing through the dies and the hollow spindle of the swaging machine to a reel at the rear. The threaded wire thus produced is not suitable for precision purposes but is extensively used for electrical and plumbers' supplies. Characteristic of the swaged thread is its accuracy in lead rather than in thread form. The form of swaged threads, however, is not excessively irregular.

The amount of reduction in diameter that can be successfully effected by the swaging process is largely an empirical matter. Small wire can be reduced the desired amount in one pass of the work through the dies, but on solid work which is large enough to withstand as great a reduction as $^1/_{16}$ in. a greater amount than this is not recommended in a single pass. This applies also to tubes if a mandrel is used, but tubing swaged without a mandrel will stand a greater reduction than this.

Some difficulty may be experienced in swaging tapered parts, particularly if the taper is abrupt, by the ends of the stock splitting, and there appears to be no remedy for this except to employ a preliminary lathe operation to break down the ends of the work. After this has been done, the ends may be successfully tapered and will not pipe or split. Where such abrupt tapers are produced, whether the stock is solid or tubular, some form of positive feeding device must be employed to overcome the axial thrust produced by the revolving dies. The Dayton swaging machine makes use of a rack-and-pinion feed for work of this type.

A high degree of accuracy can be obtained by the swaging process. In fact, swaging is extensively used for sizing wire, in which work a diameter can be readily and uniformly held to within limits of plus or minus 0.001 in., or even less for the smaller sizes. A corresponding degree of accuracy can be obtained when reducing the diameter by swaging, this accuracy increasing if anything, with the smaller diameters of work. One of the chief advantages claimed for the swaging process, as compared with machining, is the saving of stock effected. Besides saving stock and improving the physical qualities of the metal, many subsequent finishing operations, such as lapping and grinding, may be eliminated; also, the resilience of the metal is retained, as previously stated, even though it is increased in hardness and tensile strength.

The original article describes and illustrates various samples of swaged work. (*Machinery* (London), vol 18, no. 453, June 2, 1921, pp. 257–261, 8 figs., *d*)

A New Sub-Press

Sub-Press for Blanking, Drawing and Punching, J. Blakey and J. Shankley. The sub-press shown in Fig. 8 is so designed that the plunger has not to be connected to the ram of the press and does not depend on the ram for its upward motion, because this is actuated by spring *O* under flange of extended buffer plug *K*. The base *C* can be fixed in any position on the press proper and over any existing clearance holes which can be utilized to get the punchings away, instead of having to force them back into the blanks. The cap *J* screwed on to body *G* for taking up the wear on the plunger babbitt bush *H* is made strong enough to withstand the pressure of the spring *O* when buffer *K* is forced down. The blanking and drawing die *D* has four punches *F* screwed into it. Die *D* is fastened to plunger *I* by four screws and two dowel pins as shown in sketch alongside. These punches *F* are a ground fit in stripper *E* (see sketch alongside), which in turn is spigoted into the bottom of piston *M*. It will be noted that punches *F* do not reach to the face of stripper *E*. As the plunger *I* descends along with plug *K* the stock is blanked by the outside diameter of *D* and inside of die *A*. Punches *F* do not come into operation until die *D* has commenced drawing and stripper *E*, piston *M* and spring *N* are depressed, thus preventing any distortion of the blank. Knockout *P* is a tee-sectioned ring and, as will be seen, is operated by four springs

equally spaced. The holes in die *B* for punches *F* are slightly tapered to the lower end for clearance after leaving a generous amount at the top parallel. A hole, shown dotted, is drilled in the center of piston rod *M*, which meets a small hole drilled to drill through its center to allow the air when piston is forced up to escape through the hole shown in plug *L*. The cup shown in section under plunger and in view in the upper left-hand corner was made from No. 17 gage sheet brass and was $2^1/_4$ in. in diameter and $^7/_{16}$ in. deep, with four $^3/_{32}$-in. holes in the bottom. (*The Practical Engineer*, vol. 63, no. 1788, June 2, 1921, p. 349. 1 fig., *d*)

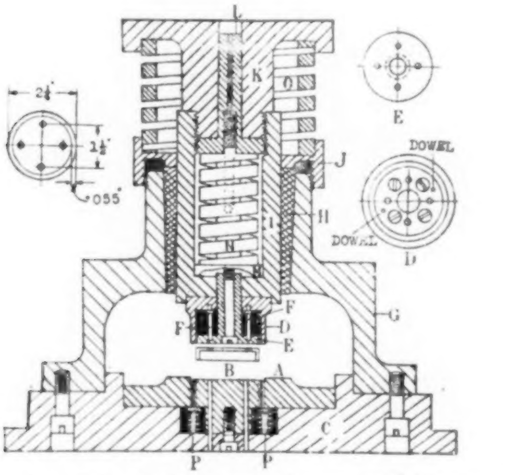


Fig. 8 Sub-Press for Blanking, Drawing and Punching

MILITARY ENGINEERING (See Engineering Materials)

POWER PLANTS

Boiler Corrosion

The Corrosion of Steam Boilers. As soon as steam turbines took their place as the standard type of prime mover for large powers, engineers hoped that the greater part of their boiler troubles would be over. The availability of the condensed steam, with its freedom from all scale-forming salts or traces of oil, for boiler-feeding purposes, opened up prospects of a new era in the boiler room. Experience, however, showed that a very soft feedwater involved troubles of its own, though just why soft feedwater attacks boilers is not quite certain. The opinion most commonly held is that with very soft water, corrosion is due to oxygen or carbon dioxide dissolved in the water. If this is so, it is desirable to avoid as much as possible the exposure of the condensate to the atmosphere and especially prevent all unnecessary agitation of the water in the presence of air. This led to the advocation of closed condensate systems. Another method consisted merely in bringing the feedwater into intimate contact with an extensive surface of unprotected iron, the idea being that the water should be allowed to satisfy its craving for iron by attacking metal specially provided for the purpose.

The engineer of a large London power station some time ago tried the experiment of filling his hot well with pieces of old boiler tubes. They were strongly attacked by the water, which was found to contain far less dissolved oxygen after passing over them than did the air-pump discharge. In the course of time, however, the action practically ceased on account of the protective coating of rust which was formed on the tubes. Mr. Kestner (paper before joint meeting of the Institution of Mechanical Engineers and Society of Chemical Industry, Mar. 4, 1921) secured continuous operation by reversing the direction of flow of feedwater. In another instance interesting results were secured by fitting some of the boilers with cast-iron economizers and the rest with steel ones. With the same feedwater, corrosion took place in the boilers with cast-iron economizers, but not in the others, the steel economizers themselves being attacked.

This would indicate that the corrosive capacity of feedwater is limited and may be eliminated by giving the water something to attack. In this connection it is stated that corrosion troubles were practically stopped in a certain steel economizer by filling it up with a mixture of lime and carbonate of soda, removing the safety valves and subjecting the mixture to a protracted boiling at atmospheric pressure.

The attacks are often of an erratic nature. Sometimes one boiler out of a group is attacked; at other times the main feed line along the boiler fronts is safe while considerable trouble is experienced with the smaller vertical connections of the boiler drums. These facts point to the probability that something in the composition of the steel may be a determining factor. Test by H. P. Gaze of the Central Electric Supply Co. would further indicate that ordinary commercial steel tubes supplied by the economizer makers suffer less from corrosion than charcoal-iron tubes, which would dispose of the contention that modern steel is a poorer metal in respect to corrosion than old-fashioned iron.

The author arrives at the conclusion, however, that there is more than a possibility that pitting is not entirely due to chemical causes but is rather of an electrolytic nature. A lack of perfect homogeneity in the steel would tend to cause electrical currents to circulate between different points, the currents passing through the body of the metal and returning through the water. Wherever such currents left the metal they would carry iron into solution and so eat away the surface. The suspension of a zinc plate in the boiler might not suppress these parasitic currents, as it could do nothing to alter the fact of a relative difference of potential between two points on the boiler shell.

The general conclusion arrived at is that until we can get metal which is chemically homogeneous or can devise some effective method of protecting the surface or possibly rendering it passive, corrosion can only be prevented by paying careful attention to the impurities in the feedwater. In modern plants these consist of little more than dissolved gases, which fortunately can be eliminated or neutralized without very great difficulty when once the danger of their presence is properly appreciated. (Editorial, *Engineering*, vol. 111, no. 2891, May 27, 1921, pp. 651–652, *tpA*)

Cross-Current Flow Type Water-Cooling Tower. The water-cooling tower recently erected at the Government Electric Station at Dresden, Germany, is reported to be one of the largest in Europe. It has a capacity of 120 cu. m. (28,000 gal.) per min. A feature of this type of cooler is that the air and water do not flow on the counter-current principle, but the air enters the cooler horizontally while the water falls vertically. There is a central tower or "chimney," and the entire cooling system is external to the "chimney," surrounding it at the base. There are two important advantages. The interior of the tower (which is 120 ft. high) remains quite free from obstruction, and so a very free air draft is obtainable, with a constant velocity over the whole of the "chimney." The cooling plant consists of twelve independent compartments, any one of which may be isolated for cleaning and repairs. The water enters at a height of only 16 ft. above the foundations, thus requiring much less power for its elevation than with the high type of tower. The air current, entering the spray chambers horizontally, passes transversely through the falling water and exhausts into the central tower. Its passage is very much less impeded than if it had to force its way upward against a falling spray. Less substantial foundations are necessary and much less excavation. The floor space covered is, however, somewhat greater.

The whole of the cooling chambers are roofed by shallow distributing pans, which connect to the spraying devices below. These consist of short lengths of vertical piping, delivering on to spash plates rigidly connected to the latter. The splash laths are arranged below the plates, to cause the water to assume the form of films. This region of the cooling system is boarded in to prevent wind action blowing the water outside, and the formation of ice in the air entrances. Means are also provided for a measurement

of the water supply by troughs and weirs preceding the distributing system. (*Beama* [Journal devoted to the Interest of British Electrical and Allied Engineering], vol. 8, no. 5, May 1921, p. 418, *d*)

Spray Pond Formula. In connection with the formula for computing the temperature reduction which can be effected by a spray-nozzle installation, given in Mechanical Engineering, June 1921, p. 406, the following formula having the same purpose in view, is quoted from the latest catalog of the Cooling Tower Company (15 John Street, New York City):

$$T_1 = T - \frac{[0.5\,(T+460) + 0.5(t_2+460)]^4 - (t_2+460)^4}{C \times 100{,}000{,}000}$$

Where t, t_1, T and T_1 are respectively the temperature of wet bulb or air, wet bulb, water before spraying, and water after spraying; $t_2 = (4t_1 + t)/5$ and $C = 5.1$ for average installations operating at $6^1/_2$ lb. pressure.

PUMPS

New Diagram for Determining Efficiency of Centrifugal Pumps

Determination of the Efficiency of Centrifugal Pumps, Allen F. Sherzer. The efficiency of a centrifugal pump is a function of the speed, head developed, and quantity discharged.

Since the efficiency of pumps cannot be reliably estimated solely on the basis of discharge, another method has been established in which the efficiency is made a function of the so-called constant of specific speed (N_s). This constant is supposed to include the effect of each of the variables.

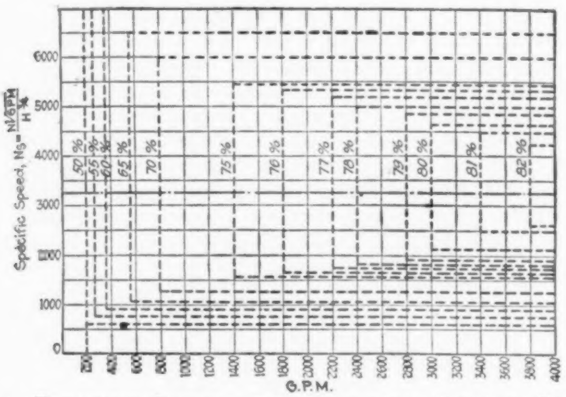


Fig. 9 Efficiency Contours for Centrifugal Pumps in Terms of Gal. per Min. and Specific Speed

The usual range of pumps have values of N_s from 500 up to about 5000, and the author shows by a curve that the efficiency increases quite rapidly with the specific speed until it reaches a maximum (N_s = about 3000), after which it falls off slowly. Moreover, he shows that the efficiency may be high over quite a range of specific speed and that, in general, there are two values of N_s corresponding to a given efficiency. Since neither capacity nor constant of specific speed alone give reliable indications as to efficiency, the author attempted to combine the two into a composite curve (Fig. 9), in which lines of equal efficiency are plotted on discharge in gallons per minute as abscissæ and values of N_s as ordinates. The lines of equal efficiency join to form a rectangle of equal efficiency. In other words, all points within the rectangle of equal efficiency are equal to or above the efficiency marked on the line enclosing them. By drawing a suitable number of these equal-efficiency lines intermediate values may be readily interpolated with sufficient accuracy.

The following instructions are given as to the use of this diagram: To make use of the diagram (Fig. 9), it is necessary to know the conditions of head, discharge, and speed under which the pump is to operate. Having these data, compute the value of N_s. Using this value of N_s as ordinate, and with the discharge as abscissæ, locate the point on the diagram in Fig. 9. In case this does not fall exactly on any of the lines shown, interpolate horizontally and vertically, which will give the probable efficiency with sufficient accuracy for all usual purposes.

An example may help to make this clear. Assume that a centrifugal pump is to be designed for a discharge of 600 gal. per min. against a total head of 120 ft. when operating at a constant speed of 1750 r.p.m., and that it is desired to estimate its probable maximum efficiency.

We first find that the value of $N_s = 1750\sqrt{(600)}/120^{3/4} = 1185$. Now turning to Fig. 9 and traveling up to the 600 G. P. M. line till we come to $N_s = 1185$, we find that the point lies at the lower left-hand corner of the 65 per cent rectangle and that its probable efficiency would be about 65 per cent or perhaps a little more. This value agrees quite satisfactorily with practical experience, but when used for power-estimating purposes it should be reduced a little for safety, as it frequently happens that the power required to drive the pump at its point of maximum efficiency is somewhat exceeded when discharging a greater quantity of water against a lower head, which may easily take place in any given installation. The accuracy of this method is necessarily limited by the accuracy of the data on which it is based, but as such were selected from various sources and include the results of tests on a great number of pumps, it is believed that it is at least representative of average practice. The method given in this paper may be readily applied to any type of pump and can be modified if necessary to accord with the experience of any who may care to make use of it. *Engineering News-Record*, vol. 86, no. 26, June 30, 1921, pp 1114–1115, 3 figs., *epA*)

RAILROAD ENGINEERING

Double-Capacity Air Brakes on the Virginian Railway. The Virginian Railway, because of its predominant tonnage of bituminous coal which has to be hauled over comparatively steep grades, is especially interested in the question of the rapidity with which traffic of that character can be handled. In particular, on the section east of Princeton, long, heavy trains have to be handled down grades of 1.5 per cent, while near Elmore the trains have to be pushed up a 2.07 per cent grade.

This has materially affected the character of the rolling stock, with the result that today the Virginian Railway operates ten of the most powerful locomotives in the world and 1000 of the highest-capacity cars ever built, namely, 120-ton.

Incidentally these cars make the braking problem very serious, owing to the fact that their weight when empty is only one-quarter of the gross weight loaded, which is very desirable from an economical standpoint but makes difficult the handling of trains composed of such cars when loaded and going down grades and the return of long trains composed wholly of empty cars.

The problem of designing proper brakes in this case lay in the necessity to compensate for the great discrepancy in weight between empty and loaded trains. With single-capacity brakes the braking force developed is constant in magnitude but varying in its relation to the car weight. The usual practice has been to design the brake layout so as to provide the highest practicable percentage of braking forces on the empty car and then to accept whatever reduced braking ratio might be available for the loaded car. This was scarcely applicable to the conditions prevailing as stated above on the Virginian Railway, because it might not have provided a sufficiently safe control of the loaded trains on the down grades, or in long trains of empties might have resulted in severe shocks because of the high braking ratio of the empty train. In fact, the high-capacity cars on the Virginian Railway operated under so divergent conditions of loaded and empty trains that any attempt at a compromise between the two extremes would have resulted in unsatisfactory operation with either one or the other. The double-capacity brake equipment solved this problem, the layout being designed to provide for 40 per cent braking ratio (as against the usual 60 per cent) for an empty car, and also 40 per cent for the loaded car as against the usual average of 15 per cent. The additional force required to raise the braking ratios on loaded cars is obtained by the combination of an additional cylinder and increased leverage, a small load reservoir supplying the additional air.

When the equipment is set for empty-car operation the take-up

and empty cylinders, which are built into one structure with the small piston operating withinthe larger, operate as one 10-in. cylinder similar to the standard single-capacity brake. When the equipment is set for loaded-car operation the take-up cylinder piston first takes up the slack in the rigging and brings the shoes firmly against the wheels. Then the empty cylinder piston moves out a slight amount, its clutch gripping the notched push rod of the take-up cylinder piston, thus supplying additional force. Finally, as the brake-pipe reduction continues, the load cylinder piston moves out a slight amount, gripping its notched push rod and adding to the force already developed, through the connecting rods and levers. By this method of slack take-up and short travel of the larger pistons the volume of air required for a given application is reduced to a minimum.

The higher braking ratio necessary for the loaded car is obtained only when desired, and the equipment is manually changed for loaded car braking by the mechanism which shifts the change-over valve to its load position. Extensive tests have been made to demonstrate the efficiency and reliability of the new brake, one of the most spectacular of which was a test on a train consisting of 100 loaded 120-ton capacity cars, the brakes operating to the complete satisfaction of every one concerned.

Among those witnessing this test were four men who were present 35 years ago at the famous Burlington test of the Westinghouse air brake, which did much toward the universal acceptance of that type of brake on American railroads. (*Railway Review*, vol. 68, no. 24, June 11, 1921, pp. 885–894, illustrated, *d*)

SAFETY ENGINEERING

Influence of Mine Atmospheric Conditions on Fatigue. The effect of varying atmospheric conditions in mines may express itself in lowering the efficiency of the defensive mechanism of the human frame against disease. Such conditions may not be directly conducive to specific diseases, such as miners' tuberculosis, and yet may lead to a more feeble resistance against them. Such conditions are the creation of an undue amount of fatigue, the presence of minute quantities of irritant poisonous gases, such as carbon monoxide, nitrogen oxide, chlorine and cyanogen chlorite, a large deficiency of oxygen, or a large excess of carbon dioxide or nitrogen.

In this connection attention is called to the fact that in recent years there have been two remarkable changes in the opinion of competent authorities on the question of the relation of atmospheric conditions in mines to health. In the first place, contrary to what was formerly believed, the opinion came to prevail that much larger amounts than 0.20 per cent of carbon dioxide are tolerated by the human system. The author doubts, however, if this truly applies to cases where people have to breathe contaminated atmosphere for a very considerable length of time.

The other question on which medical opinion has lately undergone considerable change is the effect of high temperature and humidity on health. It was formerly held that while a wet-bulb temperature of 83 deg. fahr. might greatly diminish a laborer's output of work, it had no detrimental effect on his health. The experiments with air in motion, and, more recently, the introduction of the katathermometer, have shown, however, that conditions which induce undue fatigue when performing work must be detrimental to health. (Contribution by Sir Robt. Kotze to a paper by Dr. A. J. Ornstein and H. J. Ireland before the South African Institution of Engineers. *Journal of the South African Institution of Engineers*, vol. 19, no. 10, May 1921, pp. 202–204, *gp*)

SPECIAL MACHINERY

Aluminum Casting, John G. A. Rhodin. Discussion of dies, pressure casting and defects in aluminum castings.

As regards the design of dies, the author discusses dies constructed as individual units with all clamping arrangements, etc., made and adapted for the die, and dies made in sections to suit a universal holder, like the plates in a filtering press. In England the first method has been found to be best, as it gives the designer more freedom in selecting the position of the casting in the die, combining vertical and horizontal sections, etc.

Some information is given as to the design of such dies and it is stated that the principal thing is to start working out the die from the main section and find out the smallest number of others feasible. So far such dies have been used only for making pistons of various more or less complicated design. Fans, propellers, etc., have also been made in quantity, but they belong to the class of machine parts that work without accurate fitting. Resting parts of machinery of great variety have also been cast in built-up dies and their number was increasing rapidly when the industrial stagnation came.

One of the advantages of these self-contained dies is that they can be put bodily in a furnace for heating and taken out ready for immediate pouring. With regard to limits of dimensions the writer has seen castings with runs well over 2 ft. and weighing more than 25 lb. produced in dies of this type, such as gear cases and steering wheels for motor cars. On the whole, it is stated that die casting of aluminum by gravity feed was an almost unqualified success.

As regards the building up of a number of dies in the shape of plates capable of being handled in a screw press, the author is less optimistic. For very simple things the plan is satisfactory, but for complicated castings it is claimed to be hopeless. The plates were supposed to slide on bars, but the bars proved to be in the way of everything when the casting had to be removed. The dowel pins holding the outside plate of the die were found to have a tendency to stick on slight provocation, and, in general, while the whole thing worked occasionally, the universal application of the principle was abandoned.

The gravity method is not suitable for use on castings with very thin sections when high pressure must be used. Plunger pressure has proved successful with small castings of antimonial lead, but aluminum would spoil the fit of a plunger in no time. Because of this, the majority of pressure-casting machines are worked by compressed air.

The author tried a number of machines obtained from America in 1919 and says that with aluminum he had no luck. At the start really marvelous castings were produced, but in many cases the perfection was only apparent as they were full of gas bubbles under the skin.

His criticism of the design of these machines is that to begin with the permanent contact of the molten metal with iron is totally unnecessary and the same applies to the exposure of a large surface to the air. Furthermore, the gas in the castings is air which passes by hammer action through faulty design of the goose neck.

Generally, the author believes that the market for pressure die castings in England is confronted with serious difficulties not of a technical nature—purely the objection of the English public to articles produced from uniform patterns.

As regards defects in aluminum castings, blowholes are mentioned. They are apparently the result of an evolution of gas dissolved in the metal and are nearly always associated with overheating of the metal. Certain impurities like manganese, and to a lesser extent, iron, enhance the effect. (Aluminum and Its Alloys in Engineering, serial article, section 7, chapter 5; *The Engineer*, vol. 138, no. 3416, June 17, 1921, pp. 635–636, *p*)

SPECIAL PROCESSES

Development of the Bolt and Nut Industry, F. H. Chapin. The first machine-made bolt was produced in this country only 80 years ago, Micah Rugg, a country blacksmith in Connecticut, being the pioneer of the bolt industry in this country. Southington, Conn., can truly be said to have been the cradle of the bolt and nut industry in the United States.

The first heading machine was made by W. E. Ward about 1850 and used in making carriage bolts. In those days the $^{5}/_{16} \times 3$-in. carriage bolt sold for about $33 per thousand and the bolt maker's wage was $1 per day of 12 hours. Now, this same bolt is sold for about $7.50 per thousand and the operators make from $6 to $8 per day for 10 hours' work.

It was only about the time of the Civil War that Wm. J. Clark of Milldale, Conn., brought out a method of forging carriage bolts from round iron. A little before that the manufacture of bolts by the cold forging process began.

The real development of the industry began with the advent of the method of making bolts from round iron.

As regards the industry as it is today, one of the most striking

features is the apparent total lack of standardization. Bolts and nuts are articles which function in such a simple manner that one would expect uniformity of types and sizes to come about practically automatically. As a matter of fact, the very opposite happens to be the case. The Upson Works of the Bourne-Fuller Co. alone have in their shops over 30,000 different dies for forging, trimming and threading, none of which are duplicates nor are considered entirely obsolete. (*The Iron Age*, vol. 107, no. 24, June 16, 1921, pp. 1609–1610, *g*)

British Seamless-Steel-Tube Manufacture

SEAMLESS-STEEL-TUBE MANUFACTURE. Review of the processes with especial reference to British practice, in particular such as employed by Accles & Pollock, Ltd., Oldbury, Birmingham, England.

Essentially the methods employed do not differ much from American methods. Great difficulty is said to be experienced in drawing tubes below $^7/_{16}$ in. diameter on a mandrel, and the usual practice adopted for finishing all sizes $^3/_8$ in. and under is by reducing the diameter only. (This process is called "sinking.") The tubes finished in this manner are not as consistent in quality as those finished on a mandrel and are not as strong.

Aircraft construction called for high-carbon and alloy-steel tubing, in particular chrome-nickel steel. At first trouble was experienced and mandrels and occasionally draw benches were broken through unsatisfactory annealing processes. These difficulties however, have been successfully overcome and chrome-nickel steel tubing is now being produced by the same plug-drawing process as used for mild steel, although the amount of reduction per draw is not nearly as great and care has to be exercised in annealing.

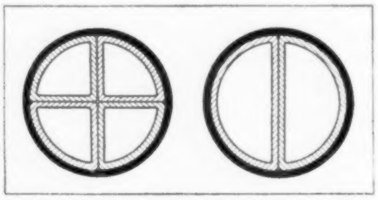


FIG. 10 EXAMPLES OF TWO TYPES OF REINFORCED STEEL TUBE

Reinforced tubes are also made. In the case of the flattened ends of struts on the rods it is quite common practice to insert a flat strip of steel, and rivet and solder it in position. This is not very satisfactory, however, as, unless some additional strengthening is provided, the tube is always weakened at the point where it changes its shape. A far more efficient method is that of inserting a tubular liner before flattening to extend some distance beyond the trapped portion. In Fig. 10 the tube to the left is formed by drawing a round tube over two D-sections. This particular combination was designed to withstand excessive vibration. The other combination is formed in the same manner but has four inner tubes. (*Engineering Production*, vol. 2, no. 35, June 2, 1921, pp. 675–679, 13 figs., *d*)

STANDARDIZATION (See Special Processes)

STREET RAILWAYS (See Machine Parts)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

N.M.T.A. AND INDUSTRIAL EDUCATION

(*Continued from page 522*)

3 Many of those who do attempt to train have nothing even approximating a definite schedule for this work, and have not definitely determined responsibility for instruction and training as part of the duties of some person or group

4 Very few foremen are able to give instructions to a learner in a proper manner

5 Conditions in the various plants determine the type of training necessary.

It is the belief of the Committee that in the majority of instances, shops with one hundred or more employees should consider seriously the establishing of a training department. In the smaller shops the quota could very properly be trained in connection with the tool room or some special department. Each plant should have some individual in charge of, and responsible for, training.

The individual members of the Committee naturally have some preference for certain methods of training within their own establishments, but the Committee as a whole has not reached the point where it recommends any one system of training as being applicable to all plants: and when consideration is given to the size of our membership, the great differentiation in products manufactured, the vast territory covered, and the changing conditions within industry, it is unlikely that it will ever do so.

It is the opinion of the Committee that each plant should be considered individually, having a careful regard for the character of the product manufactured, the varying degrees of skill and intelligence required, the number of workers employed, the type of plant organization, the labor turnover, the method of recruiting new workers, the method, if any, of training now in use, the wage scheme, the plant spirit, the local conditions, and many more points which have a direct bearing on the question of training and education for the individual plant.

Too much stress cannot be laid upon the fact that no real permanent benefit can be expected from mere training along the lines of manual dexterity alone, unless such training is supplemented by a common-sense education of the worker, either by the employer himself or through his authorized representatives who carry to the worker the real policy of the employer.

This brings up the question of leadership in industry. The Committee believes that the only true leadership of labor must be furnished by the employers themselves, because they are the only class who are in a position to understand in a practical way both sides of the so-called labor problem. The fact that the employers have not made much progress in assuming the duties of leadership would seem to indicate that many of them do not yet fully realize that this part of their business is as essential as the efficiency of the worker.

GENERAL EDUCATION AND THE ENGINEERING PROFESSION

(*Continued from page 520*)

determination of the best procedure. There should be, furthermore, a large committee of leading educators in association with this agency to secure the necessary coöperation of all departments of society and business.

A ways and means committee of men from such organizations as the American Bankers' Association, American Defense Society, National Industrial Conference Board, Chamber of Commerce of U. S., National Civic Federation, Associated Industries of Massachusetts and New York and like bodies has been appointed to effect the creation of the above agency. The A.S.M.E. will be represented in association with other national bodies of engineers through the Engineering Foundation by Mr. W. W. Nichols, Chairman of its Committee on Education and Training in the Industries. Working with this committee will be an Advisory Committee on Education, already formed. We may therefore confidently predict that for the first time in America there will soon be a source of information and suggestion representative of a cross-section of American society and associated with all state and local interests that desire its services. The effect upon the nation should soon be manifest in the higher development of the individual by his better understanding of the forces about him.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research in Detroit and Vicinity

THE Research Committee of the Detroit Section of The American Society of Mechanical Engineers, composed of J. E. Emswiler, Chairman, Charles S. Glenn, C. J. Hirshfeld, J. C. McCabe and F. W. Steere, Secretary, has recently made its report to the Research Committee of the Society on the Survey of Research among the Industries of this district. The Committee takes this opportunity to express its appreciation and thanks for the work done by the Sectional Committee in making this survey, which included correspondence with one thousand firms.

The report will be submitted to the Society for action, but it is advisable at this time to give the following conclusions made from the results of the survey:

1 Only 14. 3 per cent of the firms canvassed have any apparent interest in the subject of research.

2 Only 2.2 per cent of the firms canvassed are doing research work that they consider of general interest to the profession.

3 Of those firms doing research work of Class A, the kind of work that appears to be receiving most attention is along the line of improved methods of producing, heat-treating, and machining steel and alloys, a kind of work upon which seven firms reported.

The kind of work reported upon by the next largest number of firms, viz., 5, is that of automobiles and accessories.

4 As is to be expected, most of the general research work is reported by the larger organizations, which indicates a commendable attitude on the part of firms that are financially able to do it, and emphasizes the importance of all means that can be employed for pooling the research interests of engineering industries, such, for example, as the recently established Engineering Research Department of the University of Michigan, and the more general facilities of the A.S.M.E. for the free exchange of ideas.

5 There appears to be a considerable amount of material in this Section's jurisdiction available at once, and in the near future, for publication in the Society's Journal, MECHANICAL ENGINEERING.

Research Résumé of the Month

A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches, which, in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A6-21. RULING SCALES BY LIGHT WAVES. See *Light A2-21*.

Cement and Other Building Materials A9-21. TESTS OF BUILDING PARTITIONS. Tests are being made on partitions made of brick and other building materials when exposed to high temperature for six hours. The test specimens are 11 ft. by 16 ft. in area and 8½ in. thick, supported by a heavy steel frame so that they can be swung into place and form the side of an oil-fired furnace. The temperature of this furnace is increased according to a predetermined program and the tests continued for six hours. Observations are made at various parts of the partition for temperatures and on the distortion caused by heating. The cold side of the panel is investigated for temperature to determine whether or not this is high enough to ignite inflammable material. Observations are also made to determine whether or not cracks develop. A number of tests are being made each month and engineers, architects or other interested parties are invited to visit the Bureau of Standards to witness these tests. Exact dates may be ascertained by correspondence. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke A10-21. COKE BREEZE AND BITUMINOUS COAL AS FUEL. John Blizard and James Neil of the Bureau of Mines have made Report 2244 on the Value of Mixtures of Coke Breeze and Bituminous Coal as Fuel for a Hand-Fired Boiler. Tests were made at the request of the Chamber of Commerce of Pittsburgh, Pa., to determine the steam value of the mixtures and to determine whether or not mixtures would give off objectionable quantities of smoke. The tests were made on a No. 60 Smith boiler with grate bars containing air spaces ½ in. wide and occupying 52 per cent of the total grate area, and also with air spaces $^1/_4$ in. wide and occupying 31 per cent of the grate area. The Smith boiler contains a mixing chamber for the purpose of smoke prevention. The fuel consisted of coke breeze and Pittsburgh run of mine coal. The breeze was of two sizes, one passing through a $^3/_4$-in. to 1-in. screen and the other through a ½-in. screen. The coke breeze weighed 48 lb. per cu. ft. and gave heating values between 9500 and 10,000 B.t.u. per lb. The coal contained 10 per cent ash and 3 per cent moisture and had a heating value of about 13,000 B.t.u. per lb. With equal weights of coal and breeze the heating value of the mixture varied from 11,300 and 11,800 B.t.u. per lb. The tests showed that mixtures of coarser coke breeze with Pittsburgh coal gave less than one half the smoke given out by the Pittsburgh coal alone. It produced 20 per cent less steam and required a stronger draft. The finer coke breeze gave about the same amount but required a much stronger draft. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A11-21. COAL-DUST HAZARD. Coal-Dust Hazard in Industrial Plants is the title of report 2246 by L. D. Tracey to the Bureau of Mines. The report discusses the various causes of explosions and ignition and concludes with a number of observations to be used in designing apparatus for the use of pulverized coal. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Heat A10-21. PYROMETRY. Technologic Paper No. 170 on Pyrometric Practice from the Bureau of Standards is now available from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 60 cents a copy.

Light A2-21. RULING SCALES BY LIGHT WAVES. The Bureau of Standards has made for and delivered to the Brown and Sharpe Company a 6-in. scale, the rulings of which have been made by using the light waves from a tube containing neon (wave length = 5800 to 6600 A). No intermediary standard was used. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Lubricants A1-21. EFFECT OF PARAFFIN WAX UPON VISCOSITY. The Effect of Crystalline Paraffin Wax upon the Viscosity of Lubricating Oil is the subject of Report 2249 by E. W. Dean and L. E. Jackson to the Bureau of Mines. Tests were made on 5-gal. samples of Pennsylvania crude petroleum by distilling at various temperatures and determining the viscosities of various fractions which were subsequently subjected to treatment which removed successive percentages of paraffin wax by chilling and filtering. The conclusions are:

1 Changes of content of paraffin wax up to a maximum of approximately 9 per cent have been shown to cause negligible variation of viscosity of the fractions cut between 250 deg. cent. and 275 deg. cent. and 276 deg. cent. to 300 deg. cent. at 40 mm. reduced pressure.

2 The value of the Bureau of Mines method for determining viscosity of vacuum-distillation fractions is not affected apparently by the fact that paraffin wax is not separated from the products that are tested.

3 Variations of paraffin wax content have negligible effect on viscosity.

4 Present results are not sufficient to prove a general rule.

Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Properties of Engineering Materials A5-21. ALUMINUM SOLDERS. The Bureau of Standards has recently completed tests on aluminum solders and the results will be found in the revised edition of Circular 78 on Solders for Aluminum. No solder has been found which will stand the corrosion test, although fused zinc chloride solders will stand corrosion for the greatest length of time. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Transportion A1-21. FIBER BOXES. In the manufacture of fiber boxes made of laminated or corrugated paper board, silicate of soda has been used to form the adhesive substance employed. Silicate of soda may be so made that a small difference in concentration produces a large change in viscosity. Solutions may be prepared which change from a sirupy liquid to a solid by the loss of as little as 10 per cent of the moisture. This behavior is closely related to the ratio of alkali to silica in the silicate solutions. In practice silicates containing more than three molecules of SiO_2 to each molecule of Na_2O are used. The absorption of moisture from the solution by the paper board produces the setting. The bond strength exceeds 500 lb. per sq. in. The silicate of soda does not attract vermin, being a mineral product. Philadelphia Quartz Company, Philadelphia, Pa. Address James G. Vail, Chemical Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work, and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Fuel Utilization B2-21. TEXAS LIGNITE. An investigation on the method of handling Texas lignite under hand-fired boilers. University of Texas, Austin, Texas. Address Prof. Hal C. Weaver.

Heat B19-21. HEATING AND VENTILATION. Prof. R. W. Noland is investigating the steam traps and vacuum valves used on radiators, utilizing new and original equipment for this purpose. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Heat B20-21. HEAT TRANSFER. A determination of constants of heat transmission for new materials as well as the study of surface and humidity effects. Address Prof. A. J. Wood, Pennsylvania State College, State College, Pa.

Hydraulics B4-21. HYDRAULIC JUMP BELOW OVERFLOW DAMS. A state of conditions determining the formation of the jump, its control and its utilization for useful purposes. Address Prof. S. M. Woodward, State University of Iowa, Iowa City, Ia.

Internal-Combustion Engines B6-21. MIXTURE REQUIREMENTS. Prof. G. A. Young and C. S. Kegerreis have investigated the effect of speed on mixture requirements of an internal-combustion engine. Previous experiments showed that load has no effect on mixture ratio. The effect of speed is investigated in this research. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Lubricants B4-21. VISCOSITY. Experimental Study of the Variation of Absolute Viscosity of Oils with Temperature is the subject of a thesis by A. R. Albouze. This will cover a large number of different oils with temperature variation from 60 to 320 deg. fahr. and incorporate all published data of other investigators. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, California.

Metallurgy and Metallography B9-21. INGOT CASTING. A study of the difficulties in making ingots of nickel and monel metal which are similar to those encountered in making steel ingots. These difficulties are due to the peculiar relation between metals and their oxides. Address John F. Thompson, Manager, Technical Dept., International Nickel Company, 43 Exchange Place, New York.

Properties of Engineering Materials B2-21. CONSTANTAN. A study of the possibility of producing copper-nickel metal directly from the furnace, using different thermoelectric specifications to eliminate subsequent selection and testing of wire. Address John F. Thompson, Manager, Technical Dept., International Nickel Company, 43 Exchange Place, New York.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

State University of Iowa D1-21. The College of Applied Science of the State University of Iowa is just putting into use its recently completed Hydraulic Laboratory. This includes a concrete flume 130 ft. long and 10 ft. wide, so arranged that it can be supplied with water to a depth of 7 or 8 ft.; a small laboratory building in which hydraulic turbines up to 51 in. in diameter can be installed for testing and experimental purposes, under a head not exceeding 10 ft. A water supply is constantly available which is never less than 100 to 200 cu. ft. per sec. and during most of the year exceeds 1000 cu. ft. per sec. In conjunction with the laboratory a recording register is in use in the Iowa River and a cable gaging station across the river, which is about 300 ft. wide at this point. It is planned to have ultimately a full equipment available for studying the rating of current meters for all kinds of weir experiments and investigation of hydraulic apparatus and machinery. Address Prof. S. M. Woodward, State University of Iowa, Iowa City, Ia.

University of Pennsylvania D1-21. The Equipment of the Mechanical Engineering Laboratory of the University of Pennsylvania contains the following apparatus:

Boilers, Etc.

A 90-hp. B. & W. boiler for 200 lb. per sq. in. working pressure with Warren Webster open feedwater heater with Lea recorder and Wainwright closed feedwater heater. Foster independently fired superheater.

Steam Engines, Condensers, Etc.

- $10^1/_4$-in. by 24-in. Corliss with surface condenser
- 8-in. by 16-in. Porter-Allen with surface condenser
- 7-in. by 13-in. by 10-in. Reeves compound with surface condenser and air pump
- $6^1/_2$-in. by 10-in. Buckeye with surface condenser and air pump
- 6-in. by 6-in. Harrisburg with surface condenser
- 8-in. by 10-in. Kingsford vertical unaflow with condenser
- Two 8-in. by 10-in. Metropolitan
- 7-in. by 7-in. Fairbanks
- Extra 515 sq. ft. surface condenser for miscellaneous testing
- 8-in. by 10-in. Ames engine.

Turbines

- 15-hp. DeLaval single-stage turbine and reduction gear
- 25-kw. Kerr turbine direct-connected to d.c. generator with condenser and air pump
- 22-hp. Terry turbine direct-connected to 4-in. Worthington centrifugal pump.

Compressors

- 8-in. by 8-in. by $9^1/_4$-in. by $14^1/_4$-in. by 8-in. two-stage air, duplex simple steam-driven Ingersoll-Sergeant air compressor with air-measuring tanks and surface condenser
- 6-in. by 11-in. by 6-in. two-stage air compressor belt-driven by 10-hp. motor
- No. 4 Sturtevant air blower belt-driven by 5-hp. motor.

Pumps

- 8-in. by 12-in. by 7-in. by 12-in. Worthington duplex compound direct-acting pump
- $7^1/_2$-in. by $10^1/_4$-in. by 10-in. vertical duplex steam pump
- 5-in. centrifugal pump direct-driven by 20-hp. motor
- 4-in. American volute pump direct-driven by 20-hp. motor
- $1^1/_4$-in. Tacony three-stage centrifugal pump direct-driven by 2-hp. motor
- 4-in. by 4-in. Deming triplex pump direct-driven by 3-hp. motor.

Hydraulic Motors

- 12-in. Doble wheel
- 12-in. Pelton wheel.

Hydraulic Measuring Apparatus

- One V-notch weir
- Two 10-in., one 15-in. and one 18-in. contracted weirs
- Two 2-in. venturi meters with manometers
- Two 5-in. venturi meters with manometers
- Numerous hook gages, tanks, platform scales and manometer for measurement of discharge from orifices and nozzles.

Stationary Gas, Gasoline and Oil Engines

- $9^1/_2$-in. by $17^1/_2$-in. Otto with suction producer and scrubber
- 6-in. by 9-in. Warren single-cylinder horizontal
- $7^1/_2$-in. by 14-in. Springfield single-cylinder horizontal
- 8-in. by 10-in. Westinghouse two-cylinder vertical
- 10-in. by 16-in. Burger single-cylinder horizontal
- $7^5/_8$-in. by $10^7/_8$-in. Foos single-cylinder horizontal
- 6-in. by $6^1/_2$-in. Mietz single-cylinder horizontal
- 5-hp. Thermoil (semi-Diesel)
- 5-hp. New Way (air-cooled).

Automobile and Airplane Engines, Etc.

- 4-in. by 5-in. four-cylinder Teetor
- $3^1/_2$-in. by $5^1/_4$-in. six-cylinder Continental
- $3^1/_4$-in. by 5-in. eight-cylinder Peerless
- 80-hp. LaRhone airplane engine
- 150-hp. six-cylinder Hall-Scott airplane engine
- 8-cylinder Hispano-Suiza airplane engine
- 12-cylinder Liberty airplane engine
- 75-hp. Sprague electric dynamometer with test stand
- Fan dynamometer
- Detroit hydraulic dynamometer
- American balanced diaphragm high-speed indicator
- Midgely optical high-speed indicator
- Schultz manograph.

Fuel and Gas Testing

- Two analytical balances
- Complete apparatus for proximate coal analysis
- Emerson bomb calorimeter
- Parr bomb calorimeter
- Junker calorimeter for gas and liquid fuels
- Two Orsat flue-gas apparatus
- Two Franklin flue-gas apparatus
- Hempel gas-analysis apparatus
- Open-cup flash-point apparatus
- Closed-cup flash-point apparatus
- Saybolt viscosimeter
- Westfals balance
- Electric furnace.

Material Testing

- Two 30,000-lb. Riehlé tension and compression machines
- Two 30,000-lb. Olsen tension and compression machines
- One 50,000-lb. Olsen tension and compression machines
- One 60,000-lb. Riehle torsion machine
- One 6,000-lb. Thurston autographic torsion machine.

(*Continued on page 557*)

Conference on Present State of Knowledge of Properties of Steam

AT an informal conference held in Cambridge, Mass., on June 23, 1921, at the instance of Mr. Geo. A. Orrok,[1] fourteen gentlemen were present, including several representing important users of steam, several makers of steam tables, several experimental experts in the heat-measurement field, and the chairmen of the three A.S.M.E. committees most directly interested.

The following facts were presented as to the range and reliability of the experimental data on which the steam tables now in use are based:[2]

Vapor pressures are apparently satisfactorily known over the whole range up to the critical point, except for some slight uncertainty below 70 deg. fahr. This uncertainty might perhaps trouble designers of cooling towers or of air-conditioning apparatus. Otherwise it is unimportant. Incidental checks on the vapor-pressure curve are always desirable, but not at present greatly needed.

Our knowledge of the heat of the liquid is most unsatisfactory. Between 32 deg. fahr. and 212 deg. fahr. the great need is for a better determination of the mean heat unit now commonly used as the fundamental heat unit of our tables. Both the mechanical equivalent of the mean heat unit and its ratio to the heat units ordinarily employed in precision calorimetry are uncertain by at least two-tenths of one per cent. While this uncertainty seems small from an engineering point of view, it appears in so basic a place that it can hardly be ignored. The corresponding fundamental units of electrical engineering are experimentally reproducable to at least ten times this accuracy.

Above 212 deg. fahr. there are only two determinations of the variation of the specific heat of water with temperature, one of which is seventy-two years old and the other sixteen. Both are, for various reasons, unsatisfactory.

The density of water under the pressure of its saturated vapor is fairly well known up to 600 deg. fahr. It is not an important quantity in engineering computations. Further measurements might therefore be considered unnecessary, were it not for the fact that substantially equivalent work must apparently be done in any case in connection with the calibration of the apparatus for other highly important work.

Latent or total heats of saturated steam have been directly measured up to about 380 deg. fahr. (181 lb. gage saturation pressure) with probable errors, which, although small from the percentage point of view, are nevertheless large from the point of view, for example, of the turbine designer. This sort of measurement is very difficult to make with the desired accuracy, and total heats along the saturation line are best determined by other means.

In the superheated region three sorts of measurements can be made, namely, measurements of the specific volume, measurements of the specific heat at constant pressure, and measurements of the Joule-Thomson "cooling effect," each being determined as a function of pressure and temperature over any desired range of the variables. Theoretically, any one of these kinds of measurement, if made with sufficient accuracy, would suffice for the computation of a complete steam table (provided that various functions which appear as constants of integration were known, as is now largely if not wholly true). If, then, two of these quantities are measured, there is a check on the experimental work. If all three are measured, there is a triple check. Considering the difficulty of the precise experimentation in the whole field, such a multiple check is highly desirable.

On volumes, the Munich experiments are generally regarded as the best available. Their range is from atmospheric pressure up to about 150 lb. gage, and from saturation to a superheat that is sometimes as low as 20 deg. fahr. and is never as high as 100 deg. fahr. Their accuracy is good enough from the practical point of view, but neither accuracy nor range is sufficient for any check on rates of change of either specific heats or Joule-Thomson coefficients.

On specific heats, there is the large group of Munich experiments published in three instalments and from about half an atmosphere absolute (saturation temperature about 177 deg. fahr., to about 270 lb. gage (saturation temperature about 413 deg. fahr). As to temperature, these experiments cover, at all the above pressures, the range from saturation to about 725 deg. fahr., and up to about 100 lb. gage they run up to 1100 deg. fahr. This range covers admirably present commercial conditions, but should be supplemented at the high pressure end to provide for the pioneer development work now contemplated by many designers. Except near saturation, the accuracy of these experiments is probably good enough for our present needs, although there is still room for personal judgment in fitting smooth curves to the experimental points. There are also some experiments by Thomas. At least near saturation, they are seriously affected by priming. Callendar apparently believes that this can be corrected for, and much dependable information obtained from this work. The more generally held opinion seems to be that this work requires confirmation.

On the Joule-Thomson cooling effect, there are the classical papers of Grindley, of Griessmann, and of Peake that have been discussed by everybody for about fifteen years. These experiments do not show unmistakably even the sign of the pressure coefficient of the Joule-Thomson effect, to say nothing of the magnitude of this coefficient. And when plotted against temperature, the band of points that these experiments yield is from 15 to 40 per cent wide. There is also an isolated value by Trueblood which is too lonesome to be important. And finally, in his recent book, Callendar casually introduces a dozen values, mostly at comparatively low pressures, "selected so as to cover the experimental range as evenly as possible," from a set of observations "most" of which "were taken between 150 deg. and 120 deg., and between 15 and 50 lb. pressure." The reliability of this work still rests solely on his previous reputation, since he has published no details.

The present experimental situation can, then, be summed up as follows: Vapor pressures and possibly liquid volumes are well enough known for the present; superheated specific heats are fairly well known except at pressures above 270 lb. gage; specific volumes are known directly only below 150 lb. gage and at low superheats; latent and total heats of the vapor are known directly but not entirely satisfactorily up to about 190 lb. gage; above that pressure they are not known directly at all; Joule-Thomson coefficients (from which total heats can best be determined) are scarcely known at all above 50 lb. gage; and finally, our knowledge of the heat of the liquid and of the fundamental heat unit on which the whole table is based is most unsatisfactory.

In the light of these facts, the conference agreed unanimously that the chief need at present is not so much for further discussion or study of the existing data, or even for an agreement among those interested in a "standard" table, as for more and better experimental work, especially at high pressures. They therefore outlined the appended experimental program which, in its present form, is in some ways a compromise between the best that could be wished for and what the apparatus and personnel in sight seem fitted to give. For example, the proposed work on the Joule-Thomson effect is limited to 600 lb. and 600 deg. fahr. because that is all that can be hoped for with the apparatus now available at Harvard without extensive changes and considerable delay. On the other hand, no limits are set to the range over which vapor and liquid volumes are desired, because the apparatus now available at the Massachusetts Institute of Technology is good up to the critical pressure, and at least up to the critical temperature. On the other hand, no limits are set to the range of the proposed experiments on liquid and vapor specific heats, because, although a considerable part of the development work on the necessary apparatus has already been done at the Bureau of Standards in connection with their ammonia work, the steam apparatus will have to be modified to cover any part whatever of the temperature range desired, and the efficient range of the new apparatus cannot be wholly foreseen until some work has been done on designing it. It was understood at the conference that the Bureau work could probably be pushed to 600 lb. and 600 deg. fahr., and perhaps even further in one or both directions.

(Continued on page 557)

[1] Consulting Engineer, N. Y. Edison Co.

[2] This discussion was prepared by Messrs. Harvey N. Davis, R. C. H. Heck, and E. Buckingham.—Editor.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

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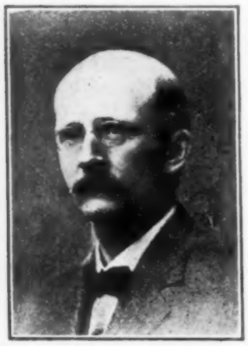
The Present State of Knowledge of the Properties of Steam

THE report of a conference which was held at Pierce Hall, Harvard University, in Cambridge, Mass., on June 23, for the consideration of the present state of knowledge of the properties of steam, is published on page 553 of this issue.



Geo. A. Orrok

During the last five years, while the divergences of the steam tables in this country have been small, we have been hearing of developments in England both in the superheated range and also with regard to supersaturation. Abstracts of a number of articles on the subject have appeared from time to time in Mechanical Engineering, including Martin's article on the new theory of turbine design (page 784, September 1918) which deals with supersaturation. Callendar's new steam tables which have been recently brought out differ widely from the more commonly used tables of Marks and Davis and of Goodenough, and these differences are of the order of one part in one hundred or larger. (A review of Callendar's book was published on page 259 of the April issue.) The minor differences between Marks and Davis and Goodenough have been covered in a paper by Professor Heck which was presented at the last Annual Meeting of the Society and was widely discussed.

It was brought out at the Cambridge conference that our heat unit is accurately known only to about one part in 300, while our electric units are known to at least one part in ten thousand. It appears that the range from 80 to 350 deg. fahr is fairly well covered, but our determinations are from fifteen to seventy-two years old and there are many minor differences. Pressures up to 160 lb. are fairly accurate, but our points in the superheated field are apparently doubted by more than one authority, the actual point and trend of the curves being problematical. Various explanations have been offered for these divergences, the latest theory being that supersaturation is responsible for most of the discrepancies.

Meanwhile, the march of progress is accelerating. Power plants using steam at 250 lb. pressure are common; 300 lb. is not unusual and at least one plant is operating at 400 lb. gage pressure. The use of even higher steam pressures is projected, and in the near future we may expect to see the use of 800 to 1000 lb. as common as is 250 lb. today. Steam temperatures are only limited by the nature of our materials of construction and 700 to 750 deg. fahr. are common, while superheater manufacturers are talking of 800 to 1000 deg. fahr. It is apparent that at the present time most of our data above 360 deg. are extrapolated and the location of the curves is a matter of personal opinion rather than of scientific fact.

The conference agreed that the only thing to do was to secure more data in the higher and lower ranges, carrying the work as far as possible but restricting it so that the results would be available in a reasonable time. From the nature of some of the apparatus available it is thought that the upper limits may be extended to 600 lb. and somewhere between 600 and 700 deg. fahr. The determination of the Joule-Thomson coefficient will determine the trend of the curves in the upper ranges, and the amount of extrapolation will be greatly reduced.

The conference expressed the belief that it will be possible to so conduct the various lines of experimentation that three independent checks on the pressure-temperature-volume relation will be obtained and many of the mooted questions which now appear in the discussion of this subject can be definitely settled for all time with an accuracy suitable to the purpose in view. The Council of The American Society of Mechanical Engineers has approved this program and the Research Committee of the Society will be charged with its administration. The results of the conference have attracted widespread interest among the manufacturers and users of steam apparatus. Geo. A. Orrok.[1]

Opportunity for Engineering Service

ABOUT February 20, 1921, New York experienced a heavy fall of snow. On Washington's Birthday, the 22nd, I was at home trying to take advantage of the holiday to catch up with my work. My attention, however, was continually distracted by the efforts at snow handling and removal going on outside. There seemed to be little planning behind the work, and much of the effort was misdirected and often harmful. Emergency work can never be highly efficient, and while this particular snowfall was handled better than had ever before been done in New York, it nevertheless left much to be desired.

Acting largely upon impulse, I sat down and dictated a letter to Mr. Calvin Rice suggesting that the Society take up the problem at a special meeting. In due time I received a reply from Mr. W. S. Finlay, Jr., saying that a meeting of the Metropolitan Section had previously been planned to be held in the fall for the consideration of the snow problem. This meeting has now been scheduled for September 23, and I have been asked to present the subject briefly in the columns of Mechanical Engineering to induce fellow-members to give it serious thought and demonstrate how much can be accomplished in solving our public problems by arousing widespread interest on the part of our Society members.

Few people realize what a vast weight and bulk is represented by a 12-inch snowfall. Possibly in New York this amounts to as much as 1,000,000 tons and more than 300,000,000 cubic feet. Calculations showing the quantity and weight will be both interesting and valuable.

The known cost of snow handling is very large,and the unknown cost due to lack of prompt removal and the impediment to traffic is perhaps much larger. Actual figures on the known cost and calculations on the unknown cost will be interesting and valuable. Listing all of the methods of handling or removing snow, and then giving comparative costs, will also be valuable.

For instance, snow can be scraped from narrow streets into nearby squares or parks. Much of it is now hauled away by trucks and wagons. It is so bulky that un'ess a special body is used a 10-ton truck with a body designed for construction material would probably be filled when it had a ton of snow on it. Query: How much weight can be loaded on a truck, and how shall we adapt the ordinary truck or wagon body to carry snow?

Special loading devices are being experimented with. Sug-

[1] Consulting Engineer, N. Y. Edison Co.

gested improvements will be in order for these devices, also for trucks with self-loading attachments.

Water is often used to flush the snow into the sewers. Except under special conditions this probably represents a very costly method of snow removal. Actual and calculated costs by this method will be valuable.

New York is using motor-driven scrapers. Suggested improvements of these machines will be valuable.

To create interest in the subject I gave to the newspapers a copy of my letter to Mr. Rice, and received a great many letters on the subject—some from engineers, but mostly from non-engineers. These letters showed how little the layman knows about the physical constants that underlie the problem—and I am sorry to say that some of the engineers showed little knowledge of the value of these physical constants and the quantities to be dealt with.

For instance, a general line of attack seems to be that of melting the snow to water and running it into the sewers. If New York has 1,000,000 tons of snow to deal with for every 12-inch snowfall, this would require greatly in excess of 10,000 tons of coal—and would still leave much labor expense to handle the snow, as it would be difficult to melt it in place.

I made a number of suggestions in my letter to Mr. Rice of methods of handling our snow, but as the space here available will not permit very extended treatment, I will have some of the correspondence printed and sent to the headquarters of the Society so that any one especially interested in the subject can send for copies.

I think the most promising suggestion I was able to make was to briquet the snow, thus compressing it to a much smaller volume and permitting it to be put in piles having vertical sides and thereby taking up very little of the width of the street. Several inventors have already gone to work to design automatic briquetting machines that will gather up the snow, briquet it and stack it. One engineer connected with a machinery-manufacturing concern of this character told me that he had worked out a preliminary design, and had made some preliminary figures on speed and cost, and that he was inclined to think that snow handling by briquetting and stacking would prove so efficient and economical that it would supersede all other methods and therefore would be applied universally.

The officers of the Metropolitan Section want to demonstrate that the big public problems can be best solved by the engineer, and to do this they must bring out at this meeting means for dealing with our snow problem vastly better than anything we now have. Will you help?

Henry L. Doherty.

A.A.A.S. Plans Engineering Activity

Mr. L. W. Wallace has recently accepted the appointment as secretary of the Engineering Section of The American Association for the Advancement of Science for the term ending with the Toronto Meeting of the Association in December.

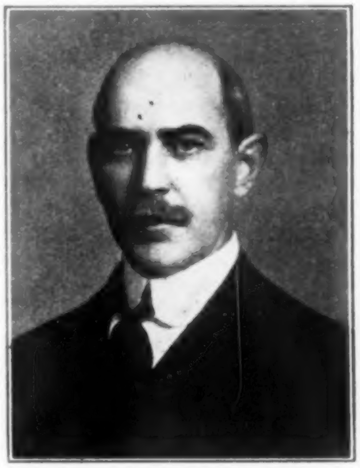
The American Association for the Advancement of Science is organized in sixteen sections, such as mathematics, physics, medicine, astronomy, engineering, etc., each of which holds its own session at the annual meeting of the Association. The American Society of Mechanical Engineers, and the other leading national engineering bodies are affiliated with the Engineering Section and nominate annually two honorary councilors. Dr. Ira N. Hollis and Prof. Robert W. Angus are the nominees this year.

Mr. Wallace, Secretary of the American Engineering Council of The Federated American Engineering Societies, which organization embraces the whole profession, will bring to his new work a keen understanding of the needs of the engineering profession in developing contacts that will add to it dignity and usefulness. The activity of the Engineering Section of the American Association for the Advancement of Science leading up to the convention in Toronto next December should be productive of greater understanding, not only between the branches of pure and applied science but between the various branches of engineering represented in the Engineering Section. In other words, another link has been added to the chain of engineering and professional coöperation.

To achieve the true ideal of service the engineering professions should have many professional alliances. Although the engineer may occupy a strategic position of service to the public, he can accomplish little alone. The true ideal can be attained only by coöperation of the broadest nature.

Frederick F. Sharpless Elected New Secretary of the Mining Engineers

At a meeting of the Board of Directors held on June 24, Frederick Fraley Sharpless, mining engineer and metallurgist, educator and editor, was unanimously elected secretary of the American Institute of Mining and Metallurgical Engineers, to succeed Bradley Stoughton, whose resignation was noted in our July issue.



Frederick F. Sharpless

Mr. Sharpless is a native of Pennsylvania and a graduate of the University of Michigan, class of 1888. He was professor of metallurgy at the Michigan School of Mines for five years and American representative of the Consolidated Mines Selection Co., Ltd., London, for fourteen. He has traveled widely throughout the United States, as well as in Alaska, Canada, Mexico, Central and South America, Asia and Africa.

In addition to having been a member of the A.I.M.E. for thirty-two years, Mr. Sharpless holds membership in the Mining and Metallurgical Society of America and the Institution of Mining and Metallurgy of London. His varied experience and wide travels make him especially well fitted for the office.

War-Invention Disclosures

Since the armistice there has been a flood of information published as to war inventions made by the various military agencies of the United States, and this flood is still continuing.

In Great Britain a similar policy was followed at first, but as time goes on less and less information is being published, considerable secrecy being maintained in regard to really important things. Thus, for example, while a very large volume of data is available in print as to the production of military gases by the Chemical War Service of the United States Army, comparatively little is known as to what similar agencies have done in England.

Only driblets of information regarding the military secrets of the French Army have become available through French sources, and next to nothing has been made public by the Germans as to their technical achievements during the war.

A New Management Magazine

The first issue of management engineering, styled "The Journal of Production," appeared July 1. It is published by the Ronald Press Company, under the direction of Leon P. Alford, Vice-President A.S.M.E., a technical editor of experience who served in that capacity on the *American Machinist* for nine years and on *Industrial Management* for two years. Mr. Alford is assisted by E. W. Tree, formerly associate editor of Mechanical Engineering.

The July number contains articles on a number of the fundamentals of management engineering, such as, The Training of Foremen, Responsibilities of Management, Educational Courses in Management Engineering, Cost Accounting, and Storeskeeping. The leading article is a contribution from Edwin S. Carman, President A.S.M.E., entitled The Pioneer Spirit in Engineering.

Each of the articles is indexed according to the Brussels classification of the Dewey decimal system, and Harrison W. Craver, director of the Engineering Societies Library, presents a method

by which this system of classification may be utilized to advantage by the engineer in connection with his own library.

Dr. Philip B. Woodworth New President of Rose Polytechnic Institute

Rose Polytechnic Institute has selected as its president Dr. Philip B. Woodworth, to succeed Dr. C. L. Mees who resigned in 1919 upon the completion of twenty-seven years of service.

Dr. Woodworth was graduated from Michigan State Agricultural College in 1886 with the degree of B.S.; he received the degree of Master of Engineering in electrical engineering from Cornell University in 1890. The year of 1891–92 he spent as a student of engineering and science at the University of Berlin. In 1920 his alma mater conferred upon him the honorary degree of Doctor of Science. Dr. Woodworth began his teaching experience in the Michigan public schools before entering college; in 1892, when he returned from abroad, he became professor of physics and engineering in Michigan Agricultural College. Seven years later he became professor of engineering in Lewis Institute, Chicago, and later dean, which position he held until 1917 when he was called into Government service. There he was successively executive secretary of the National Council of Defense and regional director for the North Central States, in charge of vocational training work for enlisted men.

In addition to that gained through his teaching Dr. Woodworth has had wide experience in engineering. He served as designing and consulting engineer for the Piatt Power Co. in the construction of a dam at Lansing, Mich., and for three years as superintendent of operation. He was also managing superintendent of the Lansing Street Railway for two years. He has been retained in the capacity of expert consultant by the Chicago surface lines, the Peoples Gas, Light and Coke Co., the Chicago Elevated Railway, the Chicago Telephone Co., the Commonwealth Edison Co., the Western Electric Co., the Aeolian Co., New York, the Christensen Air Brake Co., Milwaukee, and numerous other smaller corporations. The greater part of the work was done under the firm name of Rummler, Rummler & Woodworth, attorneys and engineers.

Dr. Woodworth is the author of numerous technical and education papers and of a textbook on Engineering Principles. He is a member of the American Institute of Electrical Engineers, the Western Society of Engineers, the Society of Automotive Engineers, the Society of Industrial Engineers, the Engineers' Council (Masonic organization) and also of the Chicago Electric Club.

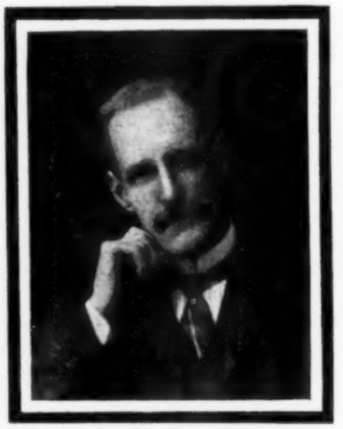
Francis Bacon Crocker Dies

Francis Bacon Crocker, eminent electrical engineer, died on July 9, 1921, at his home in New York City, at the age of sixty-one. Born in New York City, he was educated in the city schools and attended the School of Mines, Columbia University, from which he was graduated in 1882. Later he organized the school of electrical engineering at Columbia and served as its head for twenty years, when he retired because of ill health. His most important contribution to the electrical industry was the commercial motor, the first of which was put into use in 1886. This was produced in conjunction with Charles G. Curtis and Schuyler S. Wheeler as the C. & C. Co. and later the Crocker-Wheeler Co., of which he was a director at the time of his death.

Professor Crocker was one of the two American delegates to the International Electrotechnical Commission in London, and at its most important session was able to insure the standardization necessary to make worldwide electrical manufacturing successful. For this work Lord Kelvin described him as one of the world's two greatest electricians. During the war Professor Crocker acted as adviser to the Naval Consulting Board. With Peter Cooper Hewitt he developed the first successful helicopter in this country, which was taken over by the Government and put into manufacture shortly before the armistice came. He was also the author of a number of standard treatises on electric lighting and electrical machinery.

Samuel Storrow Webber

Samuel Storrow Webber, life member of The American Society of Mechanical Engineers since 1880 and manager from 1902 to 1905, died on April 27, 1921. Mr. Webber was born in Springfield, Mass., on March 31, 1854. When sixteen years of age he entered the drafting department of the Rogers Locomotive Works, Paterson, N. J. He was next associated with the Blood Manufacturing Works at Manchester, where he became acquainted with the practical side of the business. As mechanical engineer, Mr Webber accompanied several expeditions for gold dredging in California and South America. He was connected with the Trenton, N. J., Iron Works for twenty-five years, retiring in 1914.



Samuel S. Webber

Mr. Webber became a member of the Society in 1880. He was a member of the Engineers' Club of New York.

James Prentice Sneddon

James Prentice Sneddon, general superintendent of The Babcock & Wilcox Co., Bayonne, N. J., died at the Johns Hopkins Hospital, Baltimore, on June 11, 1921. Mr. Sneddon was born on July 7, 1863, in Wishaw, Scotland. He came to this country at the age of thirteen and for three years attended the public schools of St. Louis, Mo. At the end of that time he entered the employ of the Carbondale Coal & Coke Co., Carterville, Ill. So successful was his work there that he was given charge of the construction of a forty-mile railroad for the company. Convinced that he possessed engineering ability, he returned to St. Louis to serve an apprenticeship as machinist with the Rankin-Fritsch Foundry & Machine Co.

Toward the end of his apprenticeship he was sent to Indian Territory as erecting engineer, and later to the Tennessee Brewery at Memphis to install power-plant and refrigerating equipment built by his company. When the plant was put in operation he was asked to assume charge and for the next four years held the position of plant engineer. In 1889 he became master mechanic for the Pittsburgh Plate Glass Co. at their works in Crystal City, Mo., with charge of installation of all equipment. Four years later the Rankin-Fritsch Foundry & Machine Co. tendered him the position of general manager with stock interest, which he accepted, assuming full responsibility for the design and building of their line of Corliss engines and other equipment for power plants.

In 1899 he became superintendent in charge of manufacturing of the Stirling Boiler Co., Barberton, Ohio. In 1906 the company had enlarged greatly and the boiler department of Aultman-Taylor Co. was absorbed, at which time Mr. Sneddon became general manager, in charge of all manufacturing, of the Stirling Consolidated Boiler Co. In 1907 a further consolidation was made with The Babcock & Wilcox Co., and Mr. Sneddon assumed the position of general superintendent with headquarters at Bayonne, N. J. Later his duties were broadened to include the vice-presidency of the Pittsburgh Seamless Tube Co., a subsidiary of The Babcock & Wilcox Co., with full charge of all manufacturing operations for these associated companies.

The war interrupted this service in 1915, at which time he was technical adviser to the British Mission in the U. S. During the following year he was a member of the staff of J. P. Morgan & Co., export department, when they were buying and furnishing supplies for the Allied Forces. When the United States entered the war he returned to his regular duties and continued his war activities in manufacturing shell forgings, boilers and tubes for the U. S. Navy Shipping Board and essential industries.

Mr. Sneddon was a member of the Engineers' Club of New York, the Machinery Club, and the Masonic Order. He became a member of the Society in 1891.

ENGINEERING RESEARCH

(Continued from page 552)

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

International Nickel Company E1-21. The Research Department of the International Nickel Company is located at the Orford Works at Bayonne, N. J. The department occupies over 5000 sq. ft. of floor space. It is under the direction of Dr. P. D. Merica. The work of the department is along a number of lines including the following:

The possible use of non-metallic compounds such as black nickel sulphide, black nickel hydrate and nickel chromate as paint or printing pigments. Compounds of nickel oxide with zinc oxide for body colors in ceramic ware and solid nickel compounds for fungacides. Many nickel compounds are not thoroughly known by chemists. Investigations are made of their properties for use in the arts.

The laboratory is also working on the properties of monel metal, constantan, soda glass with approximately 30 per cent of sodium oxide, and black glass for table tops. A study is also being made of the properties in production of ingots in casting. Address John F. Thompson, Manager, Technical Department, International Nickel Company, 43 Exchange Place, New York.

Massachusetts Institute of Technology E1-21. The various laboratory facilities at the new plant of the M.I.T. have been increased materially since the original installation. The Road Materials Testing Laboratory has been increased and the laboratory dealing with heat treatment has been doubled in size, while the Metallographic Laboratory under the immediate charge of Dr. Fay has been made much larger. Prof. Cowdray has been specializing in the cellular structure of wood and has found that there is a great demand for information regarding this matter. Address Prof. Edward F. Miller, Massachusetts Institute of Technology, Cambridge, Mass.

Ohio State University E1-21. The Engineering Experiment Station is about to issue a bulletin on the Economy in Liquid Fuel Utilization by Professor Norman. Professor Judd is continuing his work on pulsating flow in pipes. Theses regarding the strength of fillets, friction in bearings and on the strength and elasticity of indicator cords have been completed, although they are not ready for publication. Address Prof. W. T. Magruder, Ohio State University, Columbus, Ohio.

Pennsylvania State College E2-21. The Experiment Station of the Pennsylvania State College will be engaged during the summer on investigations of heat transfer, using a new hot plate for determining constants of new materials and studying surface and humidity effects. Dr. P. Nicholls of the Franklin Manufacturing Company will work in the laboratory during the summer. The laboratory will also investigate oxy-acetylene welding and will make a preliminary study of fuels for house-heating boilers. Address Prof. A. J. Wood, Pennsylvania State College, State College, Pa.

State University of Iowa E1-21. During the next twelve months Prof. Floyd A. Nagler and two research assistants, appointed and paid by the University, will devote half of their time to the conduct of original research in the recently completed hydraulic laboratory belonging to the University. It is expected that this research will deal largely with fundamental principles regarding the flow of water over weirs. These studies will take such special direction as may seem of most immediate practical use to the engineering profession. The laboratory will welcome suggestions from engineers as to immediate needs in this direction. Address Prof. Floyd A. Nagler, State University of Iowa, Iowa City, Ia.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Petroleum, Asphalt and Wood Products F2-21. Recent Articles on Petroleum and Allied Subjects. The Bureau of Mines issued each month a bibliography on Recent Articles on Petroleum and Allied Subjects prepared by E. H. Burroughs. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

University of Pennsylvania E1-21. Among the investigations made at the University of Pennsylvania during the past year have been those relating to the efficiency of operation and mechanical construction of hoisting apparatus and the efficiency and conductivity of pipe. Address Prof. R. H. Fernald, University of Pennsylvania, Philadelphia, Pa.

CONFERENCE OF PRESENT STATE OF KNOWLEDGE OF STEAM PROPERTIES

(Continued from page 553)

The conference also discussed at some length the question of supersaturation, and its bearing both on turbine design and on the form of future steam tables. Some gentlemen felt strongly that an experimental study of this question should be added to the proposed program. All agreed that this would be highly desirable if practicable. No such action was finally agreed upon, however, partly because a definite suggestion worthy of unanimous approval as to just what ought to be attempted in a laboratory or experimental plant failed to materialize, and partly because the personnel question seemed difficult. The whole matter was therefore reluctantly laid aside for the present. It deserves thoughtful consideration by all who may by any chance be able to contribute to the desired solution.

REPORT OF THE CONFERENCE

We the undersigned, having met in informal conference in Cambridge Massachusetts, on June 23, 1921, have discussed at some length the present situation with respect to steam tables in the United States.

We feel strongly that it is of great importance to all users of steam in the United States that the properties of steam should be known with reasonable accuracy at pressures considerably higher than those at which any reliable experimental data are at present available.

After canvassing the situation we believe the following experimental program should be undertaken:

1 The specific heat of water should be determined with the greatest possible accuracy up to the boiling point of water at atmospheric pressure for the more accurate determination of the mechanical equivalent of the mean heat unit. The specific heat of water should also be determined at higher temperatures for the better determination of the heat of the liquid.

We believe that this work can best be done at the United States Bureau of Standards.

2 The pressure-temperature-volume relation of superheated steam should be determined experimentally at high pressures and over as wide a range of superheats as possible.

We believe that this work can best be done at the Massachusetts Institute of Technology under direction of Prof. Frederick G. Keyes.

3 The density of liquid water should be redetermined accurately over a wide temperature range above that at which satisfactory data are now available.

We believe that this work can best be done at the Massachusetts Institute of Technology under the direction of Prof. Frederick G. Keyes. We understand that in this connection Professor Keyes will be able to check the vapor-pressure curve of Holborn and Baumann.

4 The Joule-Thomson cooling effect in superheated steam should be determined at pressures up to 600 lb. and at temperatures up to 600 deg. fahr.

We believe that this work can best be done at the Harvard Engineering School under the direction of Prof. Harvey N. Davis.

5 Independent measurements of the specific heat at constant pressure of superheated steam should be made at higher pressures than those covered by the Munich experiments as a check on the volume and Joule-Thomson measurements. This work should be undertaken at the earliest possible moment. At present no one seems willing to undertake this work.

We believe that it could best be done at the United States Bureau of Standards, and that they should be requested to undertake it as soon as other conflicting work can be finished.

We estimate that this program could be undertaken at a cost of about $35,000 a year, and we hope that it could be completed in about three years.

We earnestly recommend that The American Society of Mechanical Engineers undertake the furtherance of this research program through its Research Committee, and that the Society undertake to receive and administer the necessary funds. We wish to recommend this program to the favorable consideration of the various interests concerned with the use of steam and to request their financial coöperation in making its realization possible.

Geo. A. Orrok	Harvey N. Davis
F. R. Low	Edwin H. Brown
Arthur M. Greene, Jr.	Robert C. Allen
Robert C. H. Heck	Ernest L. Robinson
Lionel S. Marks	H. C. Dickinson
Frederick G. Keyes	Edgar Buckingham
G. A. Goodenough per R. C. H. Heck	E. F. Mueller
	C. E. Davies.

Not present but concurring in the recommendations:

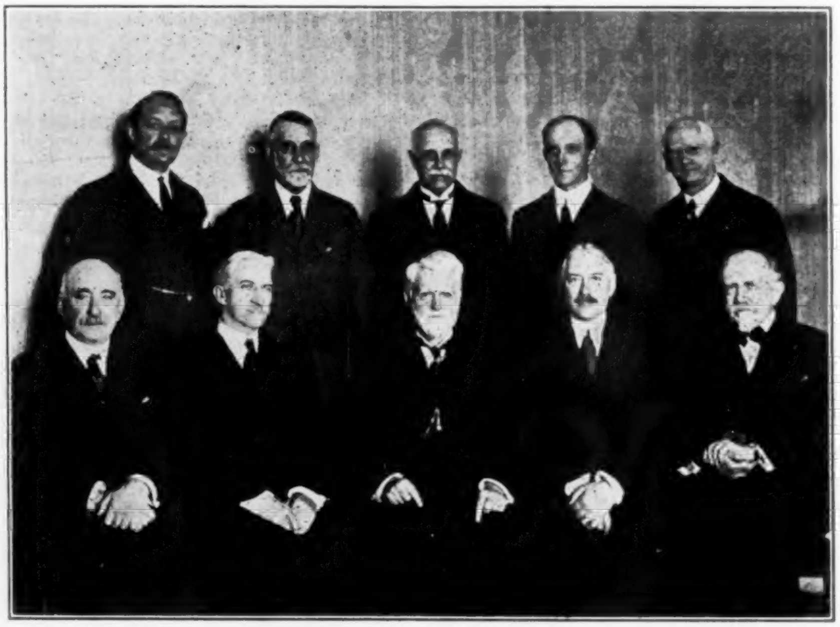
D. S. Jacobus	C. F. Hirschfeld	Francis Blossom
C. A. Adams	John E. Bell	W. F. M. Goss
C. H. Smoot	John H. Lawrence	O. P. Hood
O. Junggren	John Hunter	E. N. Trump
A. C. Flory	Percy H. Thomas	Owsley Brown
I. E. Moultrop	H. A. Lardner	C. C. Thomas
W. S. Munroe	George I. Rhodes	Peter Junkersfeld
C. E. Fisher	W. S. Finlay, Jr.	W. C. L. Eglin
W. L. Abbott	C. A. W. Brandt	W. B. Gregory.

John Fritz Medals Presented at International Gatherings

Representatives of Four National Engineering Societies Visit England and France—Sir Robert Hadfield and Eugene Schneider Recipients of John Fritz Medals—Engineering Institutions of England Confer Honorary Memberships on Visiting American Engineers

AMERICAN engineers have felt a great admiration and gratitude for the work performed by the engineers of England and France during the war and their activities in reconstruction since. The desire to convey these sentiments in a personal manner to those of the profession allied with them in the war, together with the inability of Sir Robert Hadfield, the recipient of the 1921 John Fritz Medal, to come to this country to receive he medal in person, led to the development of a plan to send a delegation of representative American engineers to England. The anticipation of the 1922 award to Eugene Schneider by the John Fritz Medal Board of Award broadened the plan so that similar ceremonies were carried out in France.

Organizers of the expedition, feeling that the scientific and technical coöperation built up during the war was a very solid foundation on which to build wider sympathies and better understandings between these three countries, therefore included the presentation of the John Fritz Medals for 1921 and 1922 as a feature of international ceremonies of marked importance in the beginning of an era of closer association of the ideals and activities of the engineers of the United States, Great Britain, and France.



Robt A Cumming Charles T. Main Jesse Merrick Smith FB Jewett William Kelly
Ira N Hollis Arthur S Dwight Ambrose Swasey Charles F Rand John R Freeman

The deputation consisted of twelve distinguished engineers representing the four national engineering societies of America. Their names and the societies they represented are as follows:

John Fritz Medal Board of Award:
Ambrose Swasey, *Chairman*

American Society of Civil Engineers:
Charles T. Main
Robert A. Cummings
John R. Freeman.

American Institute of Mining and Metallurgical Engineers:
Col. Arthur S. Dwight
Charles F. Rand, Secretary John Fritz Medal Board of Award
William Kelly.

The American Society of Mechanical Engineers:
Dr. Ira N. Hollis
Jesse M. Smith.

American Institute of Electrical Engineers:
Dr. F. B. Jewett
Dr. A. E. Kennelly
Major-General G. O. Squier.

The John Fritz Medal Fund was established in 1902 by friends and associates of John Fritz as a means of perpetuating the memory of his achievements in industrial progress, and the medal itself is one of the highest honors conferred by American engineers. It is awarded annually for scientific and industrial achievement in any field of pure or applied science, the first award being made in 1902 to John Fritz, and the second in 1905 to Lord Kelvin. Others among those who have since received the medal are George Westinghouse, Dr. Alexander Graham Bell, Thomas A. Edison, Sir William H. White, Robert W. Hunt, Elihu Thomson, Dr. James Douglas, Prof. H. M. Howe, Gen. Geo. W. Goethals, and Orville Wright. The Board of Award is made up of representatives of the four national engineering societies, one member of each society being elected annually to serve for a period of four years. The present board consists of the following men:

A.S.C.E.	Geo. H. Pegram F. S. Curtis Arthur N. Talbot Arthur P. Davis	A.I.M.E.	Herbert Hoover C. R. Corning Charles F. Rand Benj. B. Thayer
A.S.M.E.	Ambrose Swasey Henry B. Sargent F. J. Miller W. M. McFarland	A.I.E.E.	E. Wilbur Rice Calvert Townley Comfort A. Adams A. W. Berresford

Sir Robert Hadfield, the recipient of the 1921 medal, has taken a prominent part in the development of the steel industry. In addition to the invention of manganese steel, for participation in which he was awarded the medal, he has invented a magnetic steel of high permeability and other valuable steel alloys. During the war he was one of the largest producers of munitions for the British Navy. As a member of various scientific societies of Great Britain he has contributed largely to their growth; he is also an honorary member of the American Institute of Mining and Metallurgical Engineers. He is a pioneer in advocating in Great Britain the getting together of the engineering societies of the kingdom just as they have done in the United States, with common headquarters, a joint library, etc.

Eugene Schneider was awarded the 1922 medal for "achievement in metallurgy of iron and steel; for development of ordnance, especially the 75-mm. gun, and for notable patriotic contribution to the winning of the war." He has been head of the Creusot engineering and steel works of France since the death in 1898 of his father, who in his lifetime was an Hon. Mem. Am.Soc.M.E., and has given a great deal of attention to the well-being of his employees, as well as leading in the development of the steel and engineering industries of France. He is a member of various French clubs and societies and has been the recipient of many honors at home and abroad. M. Schneider is the first engineer outside the English-speaking world to receive the medal.

The presentation of the medal to Sir Robert took place at the opening conference of the British Institution of Civil Engineers in London on June 29. The meeting was attended by many eminent British engineers and scientists and also by the American ambassador and Viscount Bryce, representing Mr. Lloyd George. The president, Mr. J. A. Brodie, welcomed the deputation to the institution and to the country. Dr. Ira N. Hollis, representing the four American national engineering societies, delivered an address in which he conveyed the best wishes of the engineers of the

United States to those of Great Britain and expressed the hope that eventually engineers not only in the United States but in Canada, Great Britain and South Africa—all speakers of the same language—would be banded together for the welfare of the world. He spoke at some length on the admiration of engineers of this country for the achievements of British engineers during the war and the advantages to be gained by close coöperation between engineers of the two nations. He outlined the problems of the day in which engineers should take a leading part and closed by presenting an engrossed message to the engineers of Great Britain from the members of the four American national engineering societies in which these sentiments of admiration and good will were set forth.

Following the address by Dr. Hollis, Col. Arthur S. Dwight, representing the American Engineering Council of The Federated American Engineering Societies, as well as the American Institute of Mining and Metallurgical Engineers, presented the greetings of American engineers in the form of a resolution adopted by the Council expressing appreciation of the achievements of British engineers during the war and sympathy for the sacrifices involved, and a desire for close coöperation and mutual interest among the members of the engineering profession in England and the United States in the problems of reconstruction.

Dr. W. C. Unwin, who was asked to reply on behalf of the British engineers, spoke in appreciation of the assistance rendered by the United States in the war and of the engineering work in which engineers of the two countries are working together. He felt that the attendance of the delegation to the Conference was an indication of the better human relations spreading through the United States and Britain.

Lord Bryce, on behalf of those present who were not engineers, welcomed the delegation and shared the sentiments expressed by Dr. Hollis. He emphasized the international character of the engineering profession and congratulated members of the profession on their opportunities.

Ambrose Swasey, as chairman of the John Fritz Medal Board of Award, then presented the medal for 1921 to Sir Robert Hadfield, sketching briefly the history of the medal and the attainments of Sir Robert for which it was presented to him.

Sir Robert, in accepting the award, said that he regarded it not only as an honor conveyed upon him but as an expression to the British nation, on the part of the engineers of the United States, of their high regard and appreciation of the work of the British engineer in the war.

In connection with the award made to him Sir Robert submitted an address covering the history of the John Fritz Medal, the work of the United Engineering Societies in the United States, references to manganese steel and its applications, a general statement concerning his own research work, with a final section dealing with the history and work of the Royal Society. He has also presented a set of engineering papers and presidential and other addresses to the Engineering Societies Library, New York, to be permanently available for inspection and reference.

Other events participated in by the American delegation during its visit in England include a dinner party on the evening of June 27 given by Mr. Swasey, also one on June 28, at which the president and council of the British Institution of Civil Engineers were hosts; and an inspection of the National Physical Laboratory on June 28. On June 30 the deputation attended general meetings in the auditorium of the Institution of Mechanical Engineers, and in the evening were dinner guests of the president and council of the Institution of Electrical Engineers.

On July 8 the deputation went to Paris to present the 1922 medal to M. Schneider. The ceremonies followed the general plan of those in England. Greetings were extended to the engineers of France through La Société des Ingénieurs Civils de France in a resolution of the American Engineering Council similar to that presented to the British engineers.

The party was conducted through the Eiffel Tower by its builder, Alexandre Gustav Eiffel, who was afterward host at a luncheon which was served on the uppermost platform of the tower structure.

It is to be hoped in connection with these events bringing together engineers of Great Britain and the United States that a movement may be developed to bring into still closer coöperation the engineering societies of the British Empire according to the general plan of the American engineering societies.

During the visit of the American engineers to England and France leading engineering institutions of England conferred honorary membership upon four of the group and at a special session of the French Society of Civil Engineers, Ambrose Swasey was made an officer of the Legion of Honor and an honorary member of the Société. He also became an honorary member of the British Institution of Mechanical Engineers, the British Institution of Mining Engineers, the British Institution of Mining and Metallurgy and the Athenæum Club. The two mining institutions, the Athenæum Club, and the Iron and Steel Institute of Great Britain, conferred honorary membership upon Charles F. Rand, and the Institution of Mining Engineers honored Col. Arthur S. Dwight and William Kelly in a similar manner.

Ambrose Swasey is well known in the mechanical world and scientific circles on both sides of the Atlantic. His first inventions were the epicycloidal milling machine and a new process for generating and cutting spur gears. The Warner and Swasey Company, formed in 1880 for the manufacture of machine tools, was soon engaged also in the design and manufacture of astronomical instruments, and has been largely responsible for the development of the world's largest telescopes from the time of the 36-in. Lick refractor constructed in 1886 to the 72-in. reflecting telescope completed in 1916 for the Dominion Astronomical Observatory at Victoria, Canada.

Dr. Swasey has taken a large part in the design of these telescopes and of many other astronomical instruments, including an extremely accurate dividing engine for graduating astronomical circles. He has also developed instruments for seacoast defense and the Swasey range finder.

Dr. Swasey's efforts have ever been toward the advancement of the engineering profession and education in general, and among his many gifts for this purpose are the observatory at Denison University; the science building at the University of Nanking, China; the Y. M. C. A. building at Nanking; and $500,000 for the establishment of the Engineering Foundation.

The honorary degree of doctor of engineering was conferred upon him in 1905 by the Case School of Applied Science, and that of Sc.D. by Denison University five years later. He became a chevalier in the Legion of Honor in 1900.

Dr. Swasey has been a member of the A.S.M.E. since its organization in 1880 and was its president in 1904. He was made an honorary member in 1916. He is a member and past-president of the Cleveland Engineering Society, a member of the Institution of Mechanical Engineers of Great Britain and the British Astronomical Association, and a fellow of the Royal Astronomical Society. He was recently made an honorary member of the American Society of Civil Engineers.

Charles F. Rand, a leading figure in industrial research and a prominent mining engineer of New York City, is director and a past-president of the American Institute of Mining and Metallurgical Engineers and secretary of the John Fritz Medal Board of Award. Mr. Rand is also a member of the American Iron and Steel Institute, the National Research Council, and the American Society for Testing Materials. He is a past-president of the United Engineering Societies and chairman of the Executive Board of Engineering Foundation.

Mr. Rand is identified with the construction of railways and the opening and operation of iron mines in Cuba, and with the iron ore mining industry in the Lake Superior District, besides being largely interested in mines of manganese and copper ores.

In 1913 Mr. Rand was decorated by King Alfonso of Spain with the Grand Cross of Knight Commander (Comendador con Placa) of the Order of Isabella Catolica, for distinguished services to Spain and to mining. He now becomes one of five honorary members of the Iron and Steel Institute, the others being the Prince of Wales, King Albert of Belgium, and Dr. Richard Akerman and Baron Gustaf Tamm of Stockholm.

Col. Arthur S. Dwight, consulting mining and metallurgical engineer of New York, is vice-president of the American Institute of Mining and Metallurgical Engineers and a member of the American Electrochemical Society and the Institution of Mining and

Metallurgy (London). He is a former trustee of Columbia University and one of its leading alumni; he is actively interested in the development of the university's engineering school.

Colonel Dwight has engaged in mining and smelting in the United States and Mexico and is a patentee of the Dwight and Lloyd system of blast roasting of fine ores. He served continuously in France throughout the war, receiving the D.S.O. and other recognition for service.

William Kelly is a member and former director of the American Institute of Mining and Metallurgical Engineers. He is also a member of the Mining and Metallurgical Society of America, the Lake Superior Mining Institute (of which he was president in 1899), and the Institution of Mining and Metallurgy (London), and a fellow of the American Association for the Advancement of Science.

Mr. Kelly has had wide experience as chemist, manager and superintendent in various mining undertakings in Pennsylvania, Ohio and Michigan. He was president of the Board of Examining Engineers for Bituminous Mines Inspectors for Pennsylvania from 1885 to 1889. He has also acted as a member and as chairman both of the Public Domains Commission of Michigan and of the Board of Michigan College of Mines.

NEWS OF OTHER SOCIETIES

American Institute of Electrical Engineers

Annual convention at Salt Lake City, Utah, on June 21 to 24. Water power and long-distance transmission of electric power were the subjects of the principal papers. John L. Harper and J. A. Johnson of the Niagara Falls Power Co. surveyed the progress in the development of water power at Niagara Falls. A continuous flow of 200,000 cu. ft. per sec. passes through the Niagara River. Of the total fall of 336 ft. between Lakes Erie and Ontario, there is a head of 314 ft. that may be developed within about five miles. By an international treaty entered into in 1906 between the governments of the United States and Canada it has been agreed not to divert for power purposes more than 20,000 cu. ft. per sec. on the American side and 36,000 cu. ft. per sec. on the Canadian side. The entire amount of 20,000 cu. ft. per sec., which is available in the United States under the existing treaty, has been utilized, but with varying efficiency. One of the early plants obtains 12.1 hp. per cu. ft. per sec., while in Station No. 3 Extension, completed in 1920, 21 hp. per cu. ft. per sec. is developed. The total power generated in the five plants on the American side is 385,000 hp. If the five plants would operate at the efficiency of Station No. 3 Extension their combined power would be 420,000 hp. Thus, a loss of 34,500 hp. is traceable to inefficient utilization.

W. M. White, of the Allis-Chalmers Co., spoke on Advances in the Art of Water-Wheel Designs and Settings. The present tendency in hydroelectric practice, he said, is to develop each power site completely and to use larger units that will permit the maximum utilization of water power available. The working speed of units is increasing steadily. The best material for runners, according to Mr. White, is bronze without any zinc.

Long-Distance Transmission of Electric Energy was discussed by L. E. Imlay of the Superpower Survey, New York, N. Y. This paper was based on studies made in connection with the development of a superpower system for the industrial district along the Atlantic seaboard. In Voltage Regulation and Insulation for Large Power, Long-Distance Transmission Systems, Frank G. Baum, consulting engineer, San Francisco, Cal., proposed 220,000 volts as standard for national transmission systems. Two other papers on long-distance transmission of power were presented: Some Transmission Line Tests, by W. W. Lewis; and Notes on the Operation of Large Interconnected Systems, by L. L. Elden.

Numerous committee reports were submitted. The committee on the iron and steel industry reported progress in the simplification of control equipment for reversing-mill and finishing-mill drives. The committee on power stations pointed out developments in the design of large power stations such as the Colfax Power Station in Pittsburgh, the Hell Gate Station in New York City, the Delaware Station in Philadelphia and the Calumet Station in Chicago. Increased activities in research work in the colleges were reported by the committee on technical education.

American Society for Testing Materials

Annual meeting at Asbury Park, N. J., on June 20–24. More than 150 specifications were discussed. Of these, 71 were presented for the first time, 63 were revised, and others finally adopted as standard. Steel standards were changed to permit acceptance of steel made by duplex or more complicated processes. The provision adopted as a war emergency permitting the increase by one per cent of the sulphur and phosphorus limits on a considerable number of steel standards was removed from ten of the fourteen specifications on which it still remained. The society, however, is conducting in coöperation with other technical organizations numerous experiments to determine the effect of residual sulphur and phosphorus in otherwise normal open-hearth rolled steel products. The results thus far obtained led to the decision that it would involve no danger to extend permanently the sulphur limits from 0.05 to 0.06 per cent on structural steel for locomotives, cars and ships, owing to the heavy tonnages involved and to the continued difficulty in obtaining low-sulphur fuels and melting stock.

The phosphorus and sulphur limits were both extended 0.01 per cent for steel castings for the same reason. The sulphur limit is thus now reduced on all materials that are to be worked hot and increased on structural materials that are to be fabricated cold.

The committee on corrosion of iron and steel reported that the results of exposing uncoated sheets to atmospheric action indicated that copper-bearing metal is markedly superior in rust-resisting properties to non-copper-bearing metal of the same composition.

A preliminary specification for concrete was submitted by a joint committee composed of 25 members, five each from the American Society of Civil Engineers, the American Railway Engineering Association, the American Concrete Institute, the Portland Cement Association and the American Society for Testing Materials. The specification takes up the subject under the headings: materials, proportioning and mixing concrete, depositing concrete, forms, details of construction, waterproofing and protective treatment, surface finish, and design.

Facts regarding the testing and proportioning of concrete brought out through numerous tests conducted in various laboratories were presented by the committee on concrete and concrete aggregates. The cylindrical shape has been found to be the best for concrete specimens. A specimen having a height twice the diameter is recommended. Specimens of concrete stored in dry air from the time of mixing were found to gain but slightly in strength from 28 days up to a period of several months or even years.

R. S. MacPherran recorded tests made in the laboratory of the Allis-Chalmers Manufacturing Co. to determine the comparative properties of various alloy steels at high temperatures. The work was undertaken with a view to obtaining information as to the best material for use under operating conditions of 600 to 1000 deg. fahr. No temperature was found at which all steels showed a decided change in physical properties. The maximum tensile strength for rolled carbon steel, annealed, and forged 3.25 per cent nickel steel, annealed, occurred at between 600 and 650 deg. fahr. The maximum tensile strength usually occurred at a higher temperature than the minimum ductility. Other technical papers were: Impact Tests on Cast Steel, by F. C. Langenberg; Magnetic Spring Testing, by T. Spooner and I. F. Kinnard; A Test for Shock Strength of Hardened Steel, by C. E. Margerum; Improvements in Apparatus for Testing Petroleum Products, by T. G. Delbridge; and Some Mechanical Properties of Hot-Rolled Monel Metal, by P. D. Merica.

American Society of Heating and Ventilating Engineers

Semi-annual meeting in Cleveland on June 14 to 17. An experimental study on the resistance of materials to the flow of air was presented by A. E. Stacey, Jr. The following conclusions were formulated: (1) That the resistance of air filters varies directly with the velocity of the air through the material; (2) that the resistance is not affected by variations in relative humidity; (3) that the resistance of cotton felt is approximately 100 per cent greater than wool felt of the same weight.

A paper on By-Product Coke Ovens and Their Relation to Our Fuel Supply was read by E. B. Elliott. After reviewing the decreasing reserves of coal, petroleum, natural gas and wood and the

possibilities of conserving these fuels, Mr. Elliott pointed out the unlimited capabilities of the coking process in by-product recovery. He detailed the construction and operation of coke ovens, coke preparation and yields from a ton of coal, and studied the utilization of coke as domestic fuel. The society went on record as favoring a greater production of coke and its increasing use for domestic purposes.

Information on the application of gas to heating residences and commercial buildings was given by Thomson King. A survey of developments in the design of centrifugal fans, together with a description of a new type of multi-blade fan with double-curved blades, was presented by F. W. Bailey and A. A. Criqui (see p. 542 ante).

American Boiler Manufacturers' Association

Annual convention at Bedford Springs, Pa., on June 20 to 22. Progress was reported on the work being undertaken jointly by the Association and the Uniform Boiler Law Society in preserving unity among the states that have already adopted boiler legislation and in urging others to do so.

E. R. Fish reported as the representative of the association on the Boiler Code Committee of The American Society of Mechanical Engineers. A subcommittee was appointed by the Boiler Code Committee to consider the question of Rules for Inspection. Differences of opinion arose particularly in regard to the tolerances that an inspector may make in enforcing the Code. The apprehensions of boiler manufacturers were aroused in consequence of a questionnaire sent out to them soliciting their views. In order to assure the Association that nothing was to be done without their knowledge and coöperation, the Boiler Code Committee asked the Association to suggest some of its members to be added to the Sub-committee, and Starr H. Barnum, R. G. Cox, and Lawrence Connelly were named for that purpose. The report of the subcommittee will have to be discussed at a public hearing before it can be made a part of the Code.

F. R. Low, editor of *Power*, spoke on the Duties and Possibilities of a National Board of Boiler Inspectors. H. L. Parks, of Arthur G. McKee & Co., Cleveland, read a paper on the Proper Method of Filing and Numbering Drawings.

LIMITATIONS OF STOKERS USING MID-WEST COALS

(Continued from page 537)

high capacity. This is on account of the necessity, even with the so-called clinker grinder, of getting the clinker loosened up and into the ashpit by the use of bars in the side doors of the furnace. The ironwork at the rear of the stoker, under conditions just mentioned, comes in for very severe service, and the repairs thereto are likely to be excessive.

Some types of overfeed stokers have been used with good success in this section; and where only a limited capacity is required and suitable coal is available, results that will compare favorably with those from other stokers can be obtained.

The necessity of securing improved refractories, as well as improving the furnace design, is emphasized by the difficulties encountered with the brickwork when high boiler capacities are obtained. While this condition is probably in no way peculiar to stokers using coal from this section, it is possible that it may prove to be one of the factors governing the capacity which will be obtained in future installations.

One condition of primary importance to the stoker manufacturer has come about in the past few years, and that is that the class of help in the boiler room has improved to such an extent that a piece of equipment is not barred from consideration on the ground that it requires intelligence to operate it.

Engineering and Industrial Standardization

Elevator Standardization

The Plan and Scope Committee of the Sectional Committee on the Standardization of Elevators has completed its work and submitted its report to the Sectional Committee. The following are a few extracts from the report which it is believed will be of general interest.

The value of standardization as applied to elevators has been unanimously attested to by the representatives of all the organizations from which the members of the Sectional Committee have been selected. (See March 1921 issue of Mechanical Engineering, p. 218.) In fact, there has been a natural process of standardization as to type throughout the evolution of the modern elevator.

While it is generally recognized that the elevator has been perhaps the most important factor in the development of high buildings, very few appreciate the fact that in large centers of population in this country more passengers are carried by vertical means of transportation than by horizontal means. To give an idea of the extent of elevator traffic, it may be stated that in the Borough of Manhattan there are approximately 23,000 elevators, of which about 12,000 are passenger elevators. From data collected it has been calculated that the latter carry over 12,000,000 persons per day, which is approximately twice the number of passengers carried by the railroads and other horizontal transit facilities of Manhattan Island.

Considering the importance of vertical transportation, it is manifestly well worth while to make an earnest effort to improve the instrumentality for such service—the modern elevator. Some of the specific benefits of this standardization are as follows:

a It will give increased safety and better service to elevator users, the passengers

b It will make it possible for the owner to select an installation suitable for his purpose

c It will reduce first cost, as well as the time required to complete the elevator installation

d It will reduce the cost of maintenance and facilitate securing spare parts.

These values cannot be realized, however, unless the standards are accepted and intelligently used by producers and consumers. Hence it seems advisable that means should be provided immediately for informing both producers and consumers concerning the work which is being done, and ultimately as to the use of the proposed standards. Full publicity following careful standardization will not only tend to bring the manufacturer to a realization of the faults or incompleteness of his apparatus, but it will educate the consumer so that there will be less insistence than at present on the installation of inefficient or inadequate apparatus. To accomplish this end it is proposed to give the subject publicity in the technical press and in the publications of the organizations represented in the Sectional Committee.

The work of the Committee comprises the setting up of standards for both passenger and freight services, and their application not only to the elevator mechanism but also to the hoistway structure as an integral part of the means for vertical transportation. The result of the work should be the following:

Standards. The presentation in suitable form of—

- *a* Fundamental principles governing elevator service
- *b* Technical information sufficient for at least a general determination of elevator plants
- *c* Technical information sufficient for the formulation of specifications covering elevator plants.

Standardization of Design. The presentation in suitable form of—

- *a* Description in general of the design of the several types of hoistway structure and elevator mechanism conforming to the standards promulgated
- *b* Description in detail of the design of such parts of hoistway structure and elevator mechanism as are necessary to make them "fit" together
- *c* Description in detail of the design of such parts of both the hoistway structure and the elevator mechanism as

it may be practicable to standardize dimensionally.

In setting up the standards and in the standardization of design all of the following elements should be considered in the sequence of importance as given: (1) Safety; (2) Maintenance of Operation; (3) Quality of Service; (4) Quantity of Service; (5) Cost of Maintenance; (6) Initial Cost of Elevator Installation; (7) Depreciation and Amortization.

The Report proposes the organization of the following sub-committees to carry on this work:

1 A committee on engineering standards for passenger traffic
2 A committee on engineering standards for freight traffic
3 A committee whose problem will be the standardization of hoistway construction
4 A committee whose problem will be the standardization of elevator construction
5 A consulting committee to pass on the work of the other committees.

Copies of the complete Report may be obtained on application to the A.S.M.E. Standards Department.

A.I.E.E. Standards Submitted for Approval

The American Institute of Electrical Engineers has submitted its Standards (1921 edition) to the American Engineering Standards Committee for approval as an American Standard. This is done in accordance with the special provision in the procedure of the Committee under which important standards adopted or in process prior to 1920 may be approved without passing through the regular procedure. The standards submitted represent the latest revision of the A.I.E.E. standardization rules, revised during 1919 and 1920. These rules were first issued in 1899, so that they may be considered in truth a standard which has by actual practice proved its right to become an American Standard.

The American Engineering Standards Committee would be very glad to learn from those interested of the extent to which they make use of these specifications and to receive any other information regarding the manner in which the specifications are meeting the needs of the industry.

Standards Recently Approved by the A.E.S.C.

Standards recently approved by the American Engineering Standards Committee include four copper specifications submitted by the American Society for Testing Materials as Tentative American Standards, as follows:

Soft or Annealed Copper Wire
Lake Copper Wire, Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars
Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars
Battery Assay of Copper.

Sectional Committees Recently Designated by the A.E.S.C.

In compliance with the request of the American Institute of Electrical Engineers, the American Engineering Standards Committee has designated the A.I.E.E. sponsor for the formation of a sectional committee on Standard of Aluminum for Conducting Purposes.

In conformity with the request of a conference of interested national organizations, the American Engineering Standards Committee has designated the American Institute of Architects, the American Institute of Electrical Engineers, and the National Association of Electrical Contractors and Dealers joint sponsors for a sectional committee on Symbols for Electrical Equipment of Buildings and Ships.

Upon recommendation of its General Correlating Committee for Mining Standardization, the American Engineering Standards Committee has authorized the organization of sectional committees on Safety Rules for Installing and Using Electric Equipment in Bituminous Coal Mines Portable Electric Mine Lamps; and Storage-Battery Locomotives for Use in Gaseous Mines. The U. S. Bureau of Mines has been designated as sponsor for each of these sectional committees.

Boiler Code Committee Meets in Rochester

The June meeting of the Boiler Code Committee of the A.S.M.E. was held in Rochester, N. Y., where the Committee members were the guests of S. W. Miller, member of the Sub-Committee on Welding, F. A. Collins, Jr., Secretary of the Rochester Local Section of the Society, Roger DeWolf of the Rochester Railway Light Company, A. I. Jones and W. B. Miller of the Pfaudler Company. Through the courtesy of the Pfaudler Company, the library of their office in the Cutler Building was utilized for the Committee meetings which were held in two sessions, June 23 and 24, and the hotel headquarters of the meeting was at the Hotel Seneca.

The purpose of the meeting was to consider a report of the Sub-Committee on Miniature Boilers and a number of communications which were acted upon as formal interpretations. This report however, was tentative and the Sub-Committee received instructions from the Committee for the continuation of its work. In addition to the above proceedings, on June 23 hearings were granted to inquirers who came personally before the Boiler Code Committee.

The second day of the meeting, June 24, was devoted to revision work and excursions to a number of mechanical plants in Rochester.

TECHNICAL PROBLEMS IN AERONAUTICS

(*Continued from page 528*)

Captain Stevens also explained the need for oblique and vertical pictures which, viewed through the proper apparatus, cause the ground detail to stand out in relief. The two aerial photographs shown on page 528 illustrate oblique views at different heights.

Machine-Gun Synchronizers

IN his remarks on machine-gun synchronizers H. O. Russell emphasized the need of a synchronizing gear to control machine-gun fire to prevent bullets from striking the propeller blades, especially with the high-powered engines of today where one shot through the propeller may splinter it sufficiently to unbalance the engine, thus causing it to tear itself loose from the bed.

The synchronizing gear is essentially a mechanism connecting the engine and the trigger of the machine gun. The machine-gun fire is interrupted when the blade of the propeller is opposite the bore of the gun. The original patent taken out by the Germans in 1913 consisted of a tappet rod operating from a cam on the engine and extending to the rifle trigger. The French overcame the difficulties of wear, whip and chatter of this mechanism by utilizing an oscillating rod. The English developed the C. C. Hydraulic Gear which maintained communication between the engine and trigger by means of compressional waves in oil. Leaks and air pockets affect the proper functioning of this gear.

In the Nelson gun control the impulse from the engine is transmitted to the machine gun by a pull on a wire. This scheme has operated satisfactorily, but the wire cable must be led from the engine to the machine gun in a straight path, which limits the variety of installations possible.

Three systems have been designed and have been tested out to eliminate the defects of the Nelson gun control. One utilizes a flexible brass tube carrying the impulse cable from the engine to the machine-gun trigger through a flexible shaft. This requires a large shaft so that it will come up to speed within one-half revolution and stop within one-half revolution. Considerable work has been done upon electrical mechanisms, and although a satisfactory one has been developed, it is quite heavy and complicated. Some further advances are contemplated on the electric gear.

A Correction

In the discussion on the paper by W. M. White on the Hydraucone Regainer published in the July issue of MECHANICAL ENGINEERING, the remarks made by M. Spillman, chief engineer of the Worthington Pump and Machinery Corporation, Harrison, N. J., were in error, credited to C. B. Spellman of Philadelphia, Pa.

THE ENGINEERING INDEX

(Registered U. S. Patent Office.)

***THE ENGINEERING INDEX** presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.*

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ACCIDENT PREVENTION

Steel Erection. Instructions to Foreman for Prevention of Accidents in Steel Erection. Eng. & Contracting, vol. 55, no. 21, May 25, 1921, pp. 518–521. Prepared by erection department of McClintic-Marshall Co., Pittsburgh, Pa.

AERODYNAMICS

Motion in a Resisting Medium. Motion of the Center of Gravity of a Symmetrical Solid with Relation to a Vertical Plane Moving in a Resisting Medium (Mouvement du centre de gravité d'un solid symétrique par sapport à un plan vertical se déplaçant dans un milieu résistant), M. Alayrac. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 18, May 2, 1921, pp. 1089–1092, 1 fig. Study of mechanical problem involved and its application to aeroplane in flight.

AERONAUTICAL INSTRUMENTS

Anschutz Horizon. German Gyro Gauges, Alfred Gradenwitz. Aeronautics, vol. 20, no. 398, June 2, 1921, pp. 390–391, 5 figs. Anschutz gyrocompass for determining angle of inclination of aeroplane in regard to horizon.

Speed Indicators. The Altitude Effect on Air Speed Indicators, Mayo D. Hersey, Franklin L. Hunt and Herbert N. Eaton. Nat. Advisory Committee for Aeronautics, report no. 110, 1921, 27 pp., 8 figs. Theoretical study of experiments with venturi tubes.

AEROPLANE ENGINES

Fuels. Fuels Used in Aeroplane Engines (L'essence et les combustible employés en aviation), M. P. Dumanois. Aérophile, vol. 29, nos. 7–8, April 1–15, 1921, pp. 110–114. Utilization of other fuels than gasoline in aeroplane engines. Tests conducted by French Aeronautical Technical Service.

Liberty. Induction System Pressures in Liberty Twelve and 300 H.P. Hispano-Suiza Aeronautical Engines, U. S. War Dept., Air Service Information Circular, vol. 3, no. 223, May 1, 1921, 12 pp., 7 figs. Determination of manifold, carburetor choke and float chamber depressions in standard Liberty twelve and 300-hp. Hispano-Suiza engines.

Performance Test of G.A.X. with Two 400 H.P. Liberty "12" Engines. U. S. War Dept., Air Service Information Circular, vol. 2, no. 193, Mar. 25, 1921, 8 pp., 5 figs. Endurance, full throttle at 10,000 ft. including climb was 1 hr. 48 min.; minimum speed at sea level, lowest throttle, 63.6 m.p.h.

Packard. The Packard "Altitude" Aero Engine, J. G. Vincent. Flight, vol. 13, no. 22, June 2, 1921, pp. 371–373, 7 figs. Engine designed for use at high altitudes. Standard compression ratio is 6½ to 1, out pistons giving 5½ to 1 ratio can be fitted for low-altitude work.

Performance. Experimental Study of Performance of Aeroplane Engines in Rarified Atmosphere (Étude expérimentale du fonctionnement des moteurs en atmosphère raréfiée), Mortinot-Lagarde. Aéronautique, no. 23, April 1921, pp. 175–177, 1 fig. Experiments with Lorraine-Dietrich engine.

Radiators. Turbulence in the Air Tubes of Radiators for Aircraft Engines, S. R. Parons. Nat. Advisory Committee for Aeronautics, report no. 106, 1921, 13 pp., 12 figs. Investigation of characteristics of flow in air passages of aircraft radiators.

Superchargers. Aeroplane Superchargers, W. G. Noack. Aerial Age, vol. 13, nos. 12, 13 and 15, May 30, and June 13 and 20, 1921, pp. 272–275, 5 figs.; 322–325, 23 figs. and 347–349, 18 figs. Technical study. Design of superchargers and effect of supercharging aeroplane engines. Swiss and German types. Translated from Zeitschrift des Vereines deutscher Ingenieure.

AEROPLANE PROPELLERS

Super-Speed. Super-Speed Propellers. Sci. Am., vol. 124, no. 22, May 28, 1921, p. 430, 3 figs. Air propellers with blade-tip velocity above that of sound.

AEROPLANES

Aerofoils. Report of Wind-Tunnel Test of U.S.A. 27 A, B, and C Airfoils. U. S. War Dept., Air Service Information Circular, vol. 3, no. 224, May 10, 1921, 12 pp., 10 figs. Tables giving lift, drag, lift-drag ratio and other characteristics of various types of aerofoils.

Wings. Ground-Plane Influence on Aeroplane Wings, A. F. Zahm and R. M. Bear. Aerial Age, vol. 13, no. 13, June 6, 1921, pp. 299–301, 5 figs. Technical study discloses material ground-plane influence at small incidence and ground gap. Life is augmented drag diminished; lift-drag may be increased 30 to 40 per cent.

PW-1. U.S.A. 27 Wings. U. S. War Dept., Air Service Information Circular, vol. 3, no. 225, May 5, 1921, 4 pp. Necessary changes to make in strut locations and sizes of members when span is reduced.

AIR COMPRESSORS

Piston. The Air Losses in Piston Compressors (Die Luftverluste bei Kolbenverdichtern), Arthur Balog. Fördertechnik u. Frachtverkehr, vol. 14, no. 9, Apr. 29, 1921, pp. 99–100, 2 figs. Equations for approximate determination of losses.

[See also ELECTRIC DRIVE, Air Compresso rs.]

AIR FILTERS

Resistance. Resistance of Several Materials to the Flow of Air, A. E. Stacey, Jr. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 4, May 1921, pp. 355–364, 4 figs. Investigation showed that resistance of air filters varies directly with velocity of air through material. Resistance is not affected by variations in relative humidity.

AIRCRAFT

Design. Practical Points in the Structural Design of Aircraft, A. P. Thurston. Aeronautics, vol. 20, no. 396, May 19, 1921, pp. 355–358. Paper read before Instn. Aeronautical Engrs.

Research. The Influence of Scientific Research on Aircraft Construction (Der Einfluss der wissenschaftlichen Forschung auf die Konstruktion der Flugzeuge), K. G. Gaule. Zeit. fur Flugtechnik u. Motorluftschiffahrt, vol. 12, nos. 4, 5, 6, 7 and 9, Feb. 28, Mar. 15, 31, Apr. 15 and May 17, 1921, pp. 53–58, 73–74, 88–90, 102–106 and 133–137, 4 figs. Notes on development of relation of theory to practice. Part I deals with the development of calculating methods and constructive guide lines. Part II with development of constructive expedients.

AIRSHIPS

R.36. Britain's First Passenger Airship. Flight, vol. 13, no. 20, May 19, 1921, pp. 339–342, 7 figs R.36. Characteristics: Overall length, 672 ft. 2 in.; diameter, 78 ft. 9 in.; height from bumping bags under cars to top of hull, 91 ft. 7 in.; cubic capacity, 2,200,000 cu. ft.

ALCOHOL

Equilibrium Curves. Recovery of Volatile Solvents by the Bregeat Process, M. Roulleux and Robert G. Dort. Chem. & Metallurgical Eng., vol. 24, no. 21, May 25, 1921, pp. 916–921, 8 figs. Equilibrium curves at 20 deg. cent. between cresol and ether, ethyl alcohol, methyl alcohol, acetone and benzene. Influence of water dilution of absorbent. Operation data.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOY STEELS

Properties. Alloy-Steel—Its Rise and Secrets, A. E. White. Trans. Am. Soc. for Steel Treating, vol. 1, no. 9, June 1921, pp. 480–499, 25 figs. Composition diagrams of commercial alloy steels.

ALLOYS

Electric Resistance. On the Determination of Electric Resistance of Alloys Lead-Tin and Lead-Zinc at High Temperatures, Seibei Konno. Tohoku Imperial University, Science Reports, vol. 10, no. 1, Mar. 1921, pp. 57–74, 7 figs. From resistance-temperature curves experimentally obtained equilibrium diagrams of alloys were determined. Curves coincide almost exactly with those obtained by thermal analysis.

Equilibrium Diagrams. Theory of Metallic Alloys and Its Principal Industrial Consequences (La théorie des alliages métalliques et ses principales conséquences industrielles), M. Léon Guillet. Chimie & Industrie, vol. 5, no. 4, April 1921, pp. 371–383, 31 figs. Study of equilibrium diagrams of binary alloys.

Heat Treatment. The Extension of Heat Treatment Processes to Non-Ferrous Alloys, F. C. Thompson. Metal Industry (Lond.), vol. 18, no. 21, May 27, 1921, pp. 404–407. Note on thermal-equilibrium diagrams.

Separation of Components. New German Metallurgic Processes. U. S. Dept. of Commerce, Commerce Reports, no. 128, June 3, 1921, pp. 1282–1283. Method of separating alloys into their metal components and extracting metals from mineral ores According to process metals treated with catalytic agent go into solution in short time, treatment of large blocks of metal being effected in less than 30 min.

Testing. The Use of the Shearing Test for Determination of the Mechanical Properties of Alloys (Die Verwendung des Scherversuches zur Beurteilung der mechanischen Eigenschaften von Legierungen), Rudolf Krulla. Zeit. für Metallkunde, vol. 13, no. 6, Mar. 15, 1921, pp. 137–139, 6 figs. Account of shearing-test method and apparatus.

Zinc-Aluminum-Copper. The Utilisation of Zinc Aluminium-Copper Alloys, Pendleton Powell. Metal Industry (Lond.), vol. 18, no. 22, June 3, 1921, pp. 422–423. Methods suggested by experts to German government for disposing of large quantities of alloy left in its possession at termination of war.

[See also ALUMINUM ALLOYS; BEARING METALS; BRASS; GUN METAL.]

NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ALUMINUM

Furnaces. Gases in Aluminum Furnaces and Their Analysis, Robert J. Anderson and J. H. Capps. Chem. & Metallurgical Eng., vol. 24, no. 23, June 8, 1921, pp. 1019–1021. Portable device for sampling furnace atmospheres.

World Production. Distribution Production and Commerce of Minerals of Metals Other than Iron and Manganese (La répartition, la production et le commerce des minerals et métaux a l'exception de ce qui concerne le fer et le manganèse), Eugene Prost. Revue universelle des Mines, vol. 9, no. 2, April 15, 1921, pp. 108–131. World statistics for aluminum and mercury.

ALUMINUM ALLOYS

Uses. Aluminium and Its Alloys in Engineering, John G. A. Rhodin. Engr., vol. 131, nos. 3410–3413, May 6, 13, 20 and 27, 1921, pp. 488–489, 501, 559, and 531–532. Electrothermic production of aluminum bronze; properties and uses; uses of aluminum in brass; wiredrawing of aluminum alloys.

AMMONIA COMPRESSORS

Performance. Compressor Performance, John E. Starr. Ice & Refrigeration, vol. 60, no. 6, June 1921, pp. 427–430. Records of performance of compressors in reliquefying ammonia. Comparative test of York and De La Vergne compressors.

APPRENTICES, TRAINING OF

Methods. Training Machine Shop Workers, George A. Seyler. Iron Trade Rev., vol. 68, no. 20, May 19, 1921, pp. 1391–1392. Operation of training department in plant of Lunkenheimer Co., Cincinnati.

Research. Research on Education of Workmen (Essai d'éducation ouvrière), M. A. Bostsarron. Revue de Métallurgie, vol. 18, no. 3, Mar. 1921, pp. 163–179, 5 figs. Experimental studies conducted by French Forge Co. in training of apprentices from ages of 12 to 18 yr.

AUTOMOBILE ENGINES

Cooling System. A New Method of Cooling Automotive Engines, P. M. Heldt. Automotive Industries, vol. 44, no. 21, May 26, 1921, pp. 1103–1105, 3 figs. System intermediary between air cooling and ordinary water cooling systems. Water is used as cooling medium but jacket outlet temperature is constantly maintained above boiling point of water. Radiator core is filled with steam to certain height depending upon relation between heat absorption in cylinder jackets and heat dispersal per unit of core surface.

Flywheels. Machining Nash Flywheels, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 954–959, 3 figs. Use of vertical automatic lathes for finishing all surfaces at two settings of work

Manifolds. Disc Grinding Manifolds for Automobile Engines, J. H. Moore. Can. Machy., vol. 25, no. 22, June 2, 1921, pp. 25–28, 7 figs. Notes on grinding gear covers, manifolds, cast-iron pipe flanges, drop-forged parts, cast-iron tanks and car brasses.

Steam. The Stanley Steam Car Power Plant, Fred H. Colvin. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 955–958, 9 figs. Boiler is of fire-tube type having drawn shell. Steam pressure of from 575 to 600 lb. per sq. in. is normally carried.

Testing. Routine Factory Tests and Final Inspection of Packard Engines, J. Edward Schipper. Automotive Industries, vol. 44, no. 22, June 2, 1921, pp. 1162–1163, 2 figs. Operations include five-hour running-in during which engine is driven by electric motor and two hour dynamometer test in silent room, where measurements of power developed, compression pressure of each cylinder, fuel consumption, etc. are made, and noises are located.

AUTOMOBILE FUELS

Alcohol. Power Alcohol: Its Position and Prospects, T. Baker. Sci. & Industry, vol. 2, no. 2, Feb. 1920, pp. 95–100. Report of Power Alcohol Committee appointed by Australian Advisory Council of Science & Industry.

Power Alcohol Developments. Autocar, vol. 46, no. 1336, May 28, 1921, pp. 977–978. Natalite, an alcohol-ether mixture originated in Natal, So. Africa, is to be produced in England for automotive vehicle service.

Economical Use. Elements of Automobile Fuel Economy, W. S. James. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 543–562, 21 figs. Analytical study of factors affecting amount of power supplied car as fuel to produce at road power required for transportation. Graphs are given which show relations between characteristics of engine and power developed, also between fuel consumption and power developed under various conditions.

Naphthalene. A New Engine Fuel. H. Schrauth. Aeronautics, vol. 20, no. 398, June 2, 1921, p. 391. Conversion of naphthalene into tetra-hydro-naphthalene by chemical process.

Storage and Handling. A New Arrangement for the Storage and Handling of Inflammable Liquids (Ein neues Lager- und Förderverfahren für feuergefährliche Flussigeiten). Oel- u. Gasmaschine, vol. 18, no. 4, Apr. 1921, pp. 54–56, 2 figs. Method and arrangement employed by the Berger Works, Ltd., Berlin, according to which the liquid remains constantly under protection of a non-inflammable gas which, however, is not used to force liquid out of tank, this being effected by a hand or mechanically operated pump.

See also AEROPLANE ENGINES, Fuels; GASOLINE.

AUTOMOBILES

Headlights. Devices for Controlling Headlight Glare. Automotive Industries, vol. 44, no. 23, June 9, 1921, pp. 1199–1200, 2 figs. Crockett reflector designed to permit control of beam of light.

AVIATION

Aerial Transportation. Aerial Transportation of the Immediate Future, Ralph H. Upson. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 593–597, 3 figs. Capacity and cost curves of commercial airships based on average air speed of 70 m.p.h. Comparative cost of freight transportation by steamship, railroad, motor truck, airship and aeroplane.

Air Ports. The New Air Port of Rotterdam. Flight, vol. 13, no. 20, May 19, 1921, pp. 344, 3 figs. Besides offices and residential quarters air port will include storeroom for aeroplane parts, and two hangars, one 72 ft. by 125 ft. and the other 79 ft. by 165 ft.

Commercial. Air Transportation and the Business Man, V. E. Clark. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 563–569. Suggested business uses of aircraft.

An Air Time Table. Aeronautics, vol. 20, no. 396, May 19, 1921, p. 363. List of air fares, freight rates and time table of European airways.

Ground Engineering. Ground Engineering, H. W. S. Outram. Aeronautical Jl., vol. 25, no. 125, May 1921, pp. 237–245 and (discussion) pp. 245–250. British Government air-navigation regulations and directions issued on April 30, 1919. Examination, supervision and duties of a ground engineer.

Lighthouses. Aerial Lighthouses (Le balisage lumineux), Edmond Marcotte. Aerophile, vol. 29, nos. 7–8, April 1–15, 1921, pp. 99–107, 6 figs. Notes on design of aerial lighthouses.

Soaring Flight. Experimental Studies of Soaring Flight (Études expérimentales sur le vol à voile), M. Idrac. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 19, May 9, 1921, pp. 1161–1164, 1 fig. Graphical record of vertical components of forces acting on flying kite.

Soaring—A New Theory of Flight. (Der Segelflug, eine neue Flugtheorie), Gustav Lilienthal. Annalen für Gewerbe u. Bauwesen, vol. 88, no. 8, Apr. 15, 1921, pp. 67–71, 10 figs. Investigation of the soaring flight of birds with regard to its application to aeroplanes; possibility of eventual flight without engine.

Speed of Flight. Obtaining Very High Speeds in Aviation by Using Constant Power Engines (Les très grandes vitesses en aviation par les moteurs à puissance constante), Auguste Forissier. Génie Civil, vol. 78, no. 15, April 9, 1921, pp. 138. Reference is made to note presented by M. Rateau before Academy of Sciences on June 23, 1919 where he discussed the maximum obtainable speed under present conditions. Present writer computes that it is now possible to fly with speed of 500 km. per hr.

Weather Reports. Daily Weather Report for Aviators by Radio. Aerial Age, vol. 13, no. 13, June 6, 1921, pp. 298–299. Explanation of bulletin issued by U. S. Weather Bur. in coöperation with Office of Communications of Navy Dept. Bulletin, which is intended for benefit of marine and aviation interest, began June 1, 1921.

B

BEAMS

Concrete. Design of Simple Reinforced Concrete Structural Members—II, Harold W. Barker. Concrete, vol. 18, no. 6, June 1921, pp. 285–287, 3 figs. Formulas for computing shear and bond stresses in beams.

BEARING METALS

Genelite. Self-Lubricating Bearings. Sci. Am., vol. 124, no. 24, June 11, 1921, p. 467, 3 figs. Bearing material, termed genelite, developed by Gen. Elec. Research Laboratory. Material is mixture of graphite and high-grade synthetic bronze.

BEARINGS

Anti-Friction. A New Patent Anti-Friction Bearing. Practical Engr., vol. 63, no. 1788, June 2, 1921, pp. 347–348, 5 figs. Roller bearing manufactured by Chain Roller Bearing Co., Stockport, England. Feature is employment of endless and detachable chain as separating and guiding means for rollers.

BEARINGS, BALL

Electric Cars. Destructive Effect of Current on Ball Bearings of Electric Cars, Hilding Angstrom. Elec. Ry. Jl., vol. 57, no. 21, May 21, 1921, pp. 941–944, 13 figs. Tests made under various conditions show that very rapid destruction of ball bearings results from electric current which flows through them. Types of construction are suggested for overcoming trouble and testing apparatus is described for reproducing conditions as they occur in service.

Railway Cars. Ball and Roller Bearings and their Use in Railroad Operation (Wälzlager und ihre Verwendung im Eisenbahnbetrieb), H. Heberling. Fördertechnik u. Frachtverkehr, vol. 14, no. 5, Mar. 4, 1921, pp. 58–60, 5 figs. Longitudinal and transverse bearings; advantages of ball and roller bearings over sliding bearings; their introduction into railroad practice; Swedish tests.

Standardization. International Ball Bearing Standardization, R. S. Burnett. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 577–578. Proposed international standardization.

BENZENE

Still. A New Type of Benzene Still in European Operation, A. Thau. Chem. & Metallurgical Eng., vol. 24, no. 23, June 8, 1921, pp. 1013–1017, 11 figs. Tubular type Bamag benzene still. Still consists of number of horizontally arranged cylinder sections joined by flanged branches.

BENZOL

Recovery. A Benzol Factory of New Design at the Coking Plant of the Oxelösund Iron Works (Die Benzolfabrik neuer Bauart auf der Kokerei des Oxelösunder Eisenwerkes), A. Thau. Glückauf, vol. 57, nos. 1 and 2, Jan. 1 and 8, 1921, pp. 4–11 and 25–31, 13 figs. Factory constructed by the Berlin-Anhalt Machine-Construction Corp. (BAMAG in Sweden, in operation since beginning of 1920 including description of apparatus with which a continuous separation of the raw products in two fractions is effected. Table showing distillation of the raw products, etc., determined during period of measurements.

Recovery of Benzol from Gas (La récupération du benzol). Génie Civil, vol. 78, no. 20, May 14, 1921, pp. 409–414, 5 figs. Scheme for recovering benzol from city gas. Paper read before Société d'Encouragement pour l'Industrie nationale.

BLAST-FURNACE GAS

Cleaning. Notes on the Cleaning of Blast-Furnace Gas, S. H. Fowles. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 4, 21 pp. 7 figs. Calculations involved in design of Halberg-Beth dry-gas-cleaning plant. Comparison of Halberg-Beth plant with other plants.

BLAST FURNACES

Auxiliary Equipment. Machinery for Pig-Iron Beds at Blast Furnaces, F. W. Broy. Iron & Coal Trades Rev., vol. 102, no. 2777, May 20, 1921, pp. 689–690, 7 figs. Deals with pig breakers, crane for carrying breaking hammer and delivery magnets, and utilization of crane equipment. Translated from Zeit. des Vereines deutscher Ingenieure.

Cowper Stoves. Regulation of Pressure in Cowper Apparatus (Du regime des pressions dans les appareils Cowper), M. J. Seigle. Revue de Métallurgie, vol. 18, no. 3, Mar. 1921, pp. 140–146, 11 figs. Graphs for determining air pressure at various points of apparatus.

Hot-Blast Stoves. Design and Proportions of Hot Blast Stoves, W. E. Groume-Grjimailo. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1527–1530, 15 figs. Consideration of laws governing circulation of gases while heating and cooling. Historical designs reviewed.

Heat Distribution in Hot Blast Stoves, W. E. Groume-Grjimailo. Iron Age, vol. 107, no. 24, June 16, 1921, pp. 1613–1616, 3 figs. Hot-blast temperature equalizers. Analysis of performance results. Calculations of convection velocities.

Slags. Blast-Furnace and Cupola Slags, J. E. Fletcher. Iron & Steel Inst., annual meeting, May 5–6, 1921 advance paper no. 3, 20 pp., 12 figs. Their composition and graphic methods for determining their constitution.

BOILER FEEDWATER

Treatment. New Boiler Feed Water System. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 392–394, 2 figs. We-Fu-Go system, which consists of two reaction-settling tanks holding 80,000 gal. each, equipped with mechanically operated stirring devices, driven by individual motors.

BOILER FURNACES

Improvements. Improvements in Furnace Installations for Solid Fuels (Neuerungen an Feuerungsanlagen für feste Brennstoffe), H. Pradel. Feuerungstechnik, vol. 9, no. 15, May 1, 1921, pp. 133–137, 10 figs. Details of recent German patents.

Phillips-Badenhausen-Stephens. Vertical Process of Combustion. Power, vol. 53, no. 22, May 31, 1921, pp. 875–876, 2 figs. Fuel is introduced at front of chamber, mixed with air and cast downward building up and thereafter maintaining incoherent, incandescent bed of fuel particles on furnace bottom. In downward movement dust and fine particles are burned before reaching bed.

BOILER OPERATION

Boiler Capacity. Burning More Coal to Increase Boiler Capacity, Thomas Wilson. Power, vol. 53, no. 23, June 7, 1921, pp. 924–927, 2 figs. Increasing boiler capacity by enlarging grate area, by adding to length or width of stoker, or by using forced-draft stokers. Practice of Commonwealth Edison Co.

Feeding. Boiler Feeding by Gravitation. Engr., vol. 131, no. 3410, May 6, 1921, pp. 491–492, 4 figs. Auto-thermal feeding system.

Stoker Firing. Changing a Hand-Fired to a Stoker Fired Plant, Charles T. Main. Power, vol. 53, no. 24, June 14, 1921, pp. 954–957, 4 figs. Installation of twelve 3500-sq. ft. water tube boilers.

BOILER PLANTS

Oil-Burning. Automatic Oil-Burning Plant at Sugar Refinery, Claude C. Brown. Power Plant Eng., vol. 25, no. 12, June 15, 1921, pp. 599–602, 2 figs. Boiler plant consists of ten 600-hp. horizontal water-tube boilers.

Steel Mills. Cambria Steel Company New Boiler Plant, E. W. Trexler. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 389–392, 4 figs. Plant consists of six 655-hp. water-tube boilers equipped with underfeed stokers, superheaters, soot blowers, automatic feed-water regulators, fuel economizers, draft regulators, forced-draft and induced-draft fans.

BOILERS

Bettington. Pulverized Fuel Boiler. Eng. Rev.,

vol. 34, no. 11, May 1921, pp. 288–289, 2 figs. Bettington boiler designed to burn pulverized coal.

Efficiency. Arrangements for Improvement of the Efficiency of Steam-Heating Boilers (Einrichtungen zur Verbesserung des Wirkungsgrades von Zentralheizungskesseln), Jos. Fichtl. Gesundheits-Ingenieur, vol. 44, no. 18, Apr. 30, 1921, pp. 201–208, 9 figs. Details of various German coke-saving devices, including firebrick furnace linings, bridge walls and other devices.

Electrically Operated. Electrically Heated Steam Boilers, Eric A. Lof. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 515–518, 3 figs. Comparison of relative heating values of fuel and electric heat. Installation of electrically operated boilers in Sweden.

Marine. See MARINE BOILERS.

BOILERS, WATER TUBE

Yarrow. The Water Drums of Yarrow Boilers. Engr., vol. 131, no. 3413, May 27, 1921, pp. 566–567, 6 figs. Types recently developed.

BOLTS

Industry. Development of the Bolt and Nut Industry, F. H. Chapin. Iron Age, vol. 107, no. 24, June 16, 1921, pp. 1609–1610. First machine-fabricated product made in this country only 80 yrs. ago.

BONUS SYSTEMS

Railway Work. Piece-Work, Bonus Systems and Higher Efficiency, C. C. Cook. Ry. Age, vol. 70, no. 22, June 3, 1921, pp. 1263–1264. Experience of Baltimore & Ohio Railroad.

BRAKES

Cranes, Tests. Testing Equipment for Pneumatic Motors, J. V. Hunter. Am. Mach., vol. 54, no. 21, May 26, 1921, pp. 894–896, 4 figs. Importance of performance records for portable air motors. Examples of testing equipment in several railroad shops.

Double-Capacity. Virginian Demonstration of Double-Capacity Brake. Ry. Age, vol. 70, no. 24, June 17, 1921, pp. 1407–1410, 8 figs. Brakes for 120-ton cars. Characteristic is that equipment provides for same percentage of braking force (ratio of total shoes pressure to car weight) on loaded car as on empty car.

Stresses. Piston Travel and Shoe Clearance, H. M. P. Murphy. Elec. Ry. Jl., vol. 57, no. 25, June 18, 1921, pp. 1119–1122, 10 figs. Study of forces developed in brake riggings. Determination of relation between piston travel and shoe travel.

BRASS

Cracks. Annular Cracks, R. R. Clarke. Metal Industry (N. Y.), vol. 19, no. 6, June 1921, pp. 243–244, 2 figs. Discussion of various theories accounting for their formation. (Concluded.)

Nickel. Brasses Containing Nickel, L. Guillet. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1380. Mechanical tests and microscopic examination of copper-nickel-zinc alloys. Translated from Revue de Métallurgie.

Scrap. The Use of Scrap of New Material in Rolled Brass Foundry Work, L. Kroll. Metal Industry (Lond.), vol. 18, no. 19, May 13, 1921, pp. 364–365. Laboratory experiments. Translated from Giesserei Zeitung.

Season Cracking. Season-Cracking of Brass, H. Moore, S. Beckinsale and Clarice E. Mallinson. Chem. & Metallurgical Engr., vol. 24, no. 22, June 1, 1921, pp. 976–980, 7 figs. Investigation at Woolwich Arsenal, England, on action of corrosive agents on stressed brasses and determination of minimum loads required to produce corrosion cracks. Chemical action was found to be necessary for season cracking. (Abstract.) Paper read before Inst. of Metals.

BUILDING CONSTRUCTION

Labor Hours. Labor Hours Per Output Unit in Building Construction, Frank E. Barnes. Eng. News-Rec., vol. 86, no. 21, May 26, 1921, pp. 888–891. Tables showing time required to accomplish unit of carpenter work, masonry, excavation, painting, plastering and sheet metal work.

BUILDING MATERIALS

Research. The Utility of Research on Building Materials, Alan E. Munby. Jl. Royal Inst. British Architects, vol. 28, no. 13, May 7, 1921, pp. 373–382, and (discussion) pp. 383–390, 13 figs. Progress achieved by Science Standing Committee of Royal British Architects.

BUILDINGS

Concrete, Surface Treatment. Treatment of Exterior Surfaces of Industrial Buildings. Concrete vol. 18, no. 6, June 1921, pp. 263–265. Classification of surface treatments and suggestions in regard to method to follow in a given case. Committee Report of Am. Concrete Inst.

C

CARBURETORS

Heavy-Fuel. The Carburation Phenomena of Heavy Fuels (Zur Kritik der Vergasungsvorgänge schwerer Brennstoffe), Carl Wirsum. Motorwagen, vol. 24, no. 13, May 10, 1921, pp. 257–259. Results of experiments.

CAR DUMPERS

Gravity. Rotary Car Dump that Operates Solely by Gravity. Coal Age, vol. 19, no. 24, June 16, 1921, pp. 1074–1076, 4 figs. Gravity, springs and flywheels discharge cars by revolving them through approximately 135 deg. Cars can be dumped in full trips, hence swivel couplings are not needed.

CAR WHEELS

Cast-Iron. Proposed Tentative Specifications for Cast-Iron Car Wheels. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 4 pp.

CARS

Repair Shops. C. I. & L. Builds Modern Car Repair Shop. Ry. Age, vol. 70, no. 23, June 10, 1921, pp. 1325–1327, 4 figs. Steel-frame structure of longitudinal type 440 ft. long, 85 ft. wide and 40 ft. high.

Repairs. Scheduling Car Repairs Increases Shop Output, E. T. Spidy. Ry. Mech. Engr., vol. 95, no. 6, June 1921, pp. 349–352, 2 figs. Outline of schedule applicable to passenger or freight car repair work in large or small shops.

CARS, COAL

Hopper. A 70-Ton Hopper Car that can be Repaired in any Shop, H. Idoine. Ry. Rev., vol. 68, no. 24, June 11, 1921, pp. 894–899, 14 figs. Steel hopper car of 70-tons capacity built with interchangeable sheets and stakes.

100-Ton. Development of Coal Cars on the Norfolk & Western. Ry. & Locomotive Eng., vol. 34, no. 6, June 1921, pp. 160–163, 7 figs. Details of construction of 100-ton coal car.

New Norfolk & Western 100-Ton Coal Cars, John A. Pilcher. Ry. Mech. Engr., vol. 95, no. 6, June 1921, pp. 367–370, 10 figs. Tests to determine load on springs due to irregular track and clearance for curves.

Six-Wheel Trucks. New Designs of Buckeye Six-Wheel Trucks. Ry. Age, vol. 70, no. 22, June 3, 1921, pp. 1269–1270, 3 figs. Equalization of load is accomplished by use of equalizer casting which engages center journal.

CARS, PASSENGER

Design. On the Question of Passenger Carriages (Subject VII for discussion at the Ninth Congress of the International Railway Association), F. de Vargas. Bul. Int. Ry. Assn., vol. 3, no. 5, May 1921, pp. 461–506, 18 figs. Trend of developments in design of passenger cars by European and American railways since 1914.

Steel. The Steel Passenger Cars of the Prussian-Hessian State Railways—II, (Die eisernen Personenwagen der preussisch-hessischen Staatsbahnen), H. Speer. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 20 and 21, May 14 and 21, 1921, pp. 511–516 and 549–552, 42 figs. Present practice in construction of steel passenger cars; basic principles underlying design; construction of express-train, mail and baggage cars, and slow-train cars; recommendations for new construction of latter; repair of steel passenger cars.

CENTRAL STATIONS

Developments. Central Stations Lead in Showing Spirit of Progress, Samuel Insull. Elec. Rev. (Chicago), vol. 78, no. 23, June 4, 1921, pp. 887–890, 1 fig. Developments and possibilities of interconnected power plants and superpower zones in U. S. Paper read before Nat. Elec. Light Assn.

Electric-Furnace Load. The Electric Melting Furnace as a Central Station Load, H. A. Winne. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 510–514, 6 figs. It is estimated from past growth in installation of electric steel furnaces that in 1925 power consumption by them will total 500,000,000 kw-hr.

France. Project for the Distribution of Electrical Energy in France by Means of High-Tension Electric Networks (Projet de répartition de l'énergie électrique en France au moyee des réseaux électriquee à haute tension), Ch. Lavanchy. Revue générale de l'Electricité, vol. 9, no. 21, May 21, 1921, pp. 727–733, 1 fig. Scheme for interconnection of hydro-electric and steam power plants. Energy to be transmitted at 150,000 volts.

Industrial Heating. Industrial Heating and the Central Station, E. H. Horstkotte. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 579–582, 8 figs. Survey of progress in utilization of electric heating in industry.

Load Equalization. Load Equalization, F. L. Stone and T. W. Kennedy. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 501–504, 6 figs. Study based on typical cases, notably power house supplying five mines.

Operation. Three Years Operation at Windsor, E. H. McFarland. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 572–578, 8 figs. Central station operated jointly by American Gas & Elec. Co. and West Penn Power Co.

Steel Mills. Steel Mill Power-Factor and the Central Station, A. K. Bushmand and A. L. Lemon. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 483–486, 5 figs. Relation between full-load power factor on number of poles of induction motor.

The Use of Central Station Power in Mines and Steel Plants, K. A. Pauly. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 479–483. Notes on choice of frequency.

Superpower. Clydes Mill Station of the Clyde Valley Power Co. Elecn., vol. 86, no. 2246, June 3, 1921, pp. 686–689, 5 figs. Interconnection of steam-electric plants in and around Glasgow, Scotland.

The Superpower System—Its Scope and Relation to the United States Government, S. W. Murray. Nat. Elec. Light Assn. Bul., vol. 8, no. 6, June 1921, pp. 335–341, 1 fig. Legal, financial and economical considerations.

CHUCKS

Magnetic. Magnetic Chucks—VIII, Ellsworth Sheldon. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 945–948, 9 figs. Description of Persons-Arter chuck.

COAL

Carbonization. The Assay of Coal for Carbonization Purposes: A New Laboratory Method, Thomas Gray and James G. King. Dept. Sci. & Indus. Research (Fuel Research Board) technical paper no. 1, 1921, 12 pp., 3 figs. 1 on supp. plate. Includes table giving results of duplicate distillations of ten samples of coal, illustrating difference between yields of various products from different classes of coal.

Low-Grade. Australia's Brown-Coal Power Scheme. U. S. Dept. of Commerce, Commerce Reports, no. 117, May 20, 1921, pp. 1029–1031. Steaming value of brown coal is estimated at 50 per cent of that of black coal. Investigation of briquetting processes.

COAL BREAKERS

6000-Ton. Woodward Breaker Sizes and Prepares Six Thousand Tons of Anthracite Per Day, Dever C. Ashmead. Coal Age, vol. 19, no. 19, May 12, 1921, pp. 851–856, 10 figs. Types for sprinkling shakers and guarding shafts. Steel frame and glass walls. Chestnut washed in two sizes.

COAL CLEANING

Dry Process. Dry Cleaning of Coal by Means of Tables, Edward O'Toole. Am. Iron & Steel Inst., advance paper, May 27, 1921, 28 pp., 23 figs. Results of table tests of Indiana and Illinois coals.

[See also COAL WASHING.]

COAL STORAGE

Railways. Railways Lack Policy Toward Coal Storage Development. Ry. Rev., vol. 68, no. 22, May 28, 1921, pp. 810–819, 4 figs. Report of committee on coal storage submitted at Thirteenth Annual Convention of Int. Ry. Fuel Assn.

COAL TIPPLES

Steel. Hillsboro Wood Tipple Replaced by Steel While Shaft is Hoisting Coal, John A. Garcia. Coal Age, vol. 19, no. 19, May 12, 1921, pp. 857–860, 6 figs. Steel structure equipped with pendulum-hung three-track shaker screen, weigh pan, picking table, loading boom and like equipment.

COAL WASHING

Froth Flotation. Froth Flotation as Applied to the Washing of Industrial Coal, Ernest Bury, Walter Broadbridge and Alfred Hutchinson. Can. Min. Jl., vol. 42, no. 20, May 20, 1921, pp. 405–410, 4 figs. Also in Iron & Steel of Canada, vol. 4, no. 4, May 1921, pp. 112–119, 4 figs. Results of tests. Economic aspect of process. Paper read before Instn. Min. Engrs.

In Flotation Process Fine Coal Attaches Itself to Oil and Bubbles, Thus Floating Away with Froth, E. G. Hill. Coal Age, vol. 19, no. 22, June 2, 1921, pp. 993–995, 3 figs. Cleaning of coal by froth flotation.

COKE

Briquets. Tests with Substitute Fuels. (Versuche mit Ersatzbrennstoffen), W. Grunow. Gesundheits-Ingenieur, vol. 44, no. 18, Apr. 30, 1921, pp. 208–212, 1 fig. Results of heating tests carried out with coke briquets made from cinder and admixture of tar showed them to be poorly adapted to house-heating boilers but well adapted to Dutch-tile stoves.

Metallurgical. Study of the Efficient Use of Metallurgical Cokes (Contribution a l'étude de la valeur des cokes métallurgiques), G. Deadrière. Revue universelle des Mines, vol. 9, no. 2, April 15, 1921, pp. 93–107. Writer terms "use value" of a fuel the price which must be paid for fuel when it is substituted by another fuel, in order to effect with the former the same industrial operation that is performed with latter. Formula for use values of metallurgical cokes is developed.

COKE BREEZE

Utilization. Value of Mixtures of—Coke Breeze and Bituminous Coal as Fuel for a Hand-Fired Boiler, John Blizard and James Neil. U. S. Dept. of Interior, Reports of Investigations, Bur. of Mines, serial no. 2244, May 1921, 27 pp., 3 figs. Tests carried out at request of Chamber of Commerce of Pittsburgh in order to determine steaming value of coke breeze as fuel when mixed with Pittsburgh coal and fired by hand, and to see whether mixture when burnt would give off an objectionable quantity of smoke.

COKE OVENS

By-Product. By-Product Coke Ovens and Their Relation to our Fuel Supply, E. B. Elliott. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 381–400, 6 figs. Relative efficiencies in furnaces of coke and coal.

By-Products of Coal Distillation. Process of Extraction and Installations of Marine and d'Homécourt, Forging and Steel Manufacturing Co. at Boucau Works, France (Les produits de distillation de la hoille. Procédés d'extraction et installations de la Cie des Forges et Aciéries de la Marineet d'Homécourt aux usines du Boucau (Basses-Pyrénés), A. Grebel. Génie Civil, vol. 78, no. 22, May 28, 1921, pp. 449–454, 15 figs. partly on supp. plate. Benzol recovery and tar distillation.

The Piron By-Product Coke Ovens. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1531–1533, 3 figs. Italian vertical downward combustion type. Installation at plant of Woodward Iron Co., Woodward, Ala.

COKE PLANTS

By-Products of. Developments in the Recovery and Treatment of By-Products from Carbonization of Coal (L'évolution dans la récupération et le traitement des sous-produits de la carbonisation de la houille), Ch. Berthelot. Chimie & Industrie, vol. 5, nos. 4 and 5, April and May 1921, pp. 384–397, 23 figs., and 508–517, 12 figs. Study of recent developments and possibilities in increasing recovery of ammonia sulphate and benzol. Methods for recovery and treatment of benzol.

COMBUSTION

Control. Exhibition of Apparatus for Controlling Combustion (Compte rendu de l'exposition d'appareils servant au controle de la chauffe), Pierre Appell. Chaleur et Industrie, vol. 2, no. 4, April 1921, pp. 177–183, 10 figs. Classification and description of principal types. Exposition was organized under auspices of Société des Ingenieurs civils de France and Société d'Encouragement pour l'Industrie nationale. (To be continued.)

Measuring Combustion (La comburimétrie industrielle), M. Andre Grebel. Chaleur et Industrie, vol. 2, no. 4, April 1921, pp. 191–195, 2 figs. Description of Grebel-Velter comburimeter. (To be continued.)

The Scientific Control of Combustion, H. T. Ringrose. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 8, 9 pp., 5 figs. Use of recording apparatus for controlling combustion.

Draft Influence. Draft and CO_2 Influence on Evaporation, James T. Beard, Jr. Power, vol. 53, no. 20, May 17, 1921, pp. 775–777, 3 figs. Graphs showing relation between combustion rate and draft for various fuels.

COMPRESSED AIR

Measurement. Measuring Compressed Air Consumption in Pneumatic Tools, M. Piette. Colliery Guardian, vol. 121, no. 3149, May 6, 1921, p. 1315, 3 figs. Apparatus consisting of a venturi tube 1 in. in diameter and provided with constriction. For measuring compression of air differential gage is mounted on venturi tube.

Metering. The Metering of Compressed Air, John L. Hodgson. Mech. World, vol. 69, no. 1794, May 20, 1921, pp. 387–388, 10 figs. Installation in gold mines at Witwatersrand, So. Africa. Paper read before Midland Inst. Min., Civil & Mech. Engrs.

CONCRETE

Alkali Action. Progress in Investigation of Alkali Action on Concrete, E. C. Bebb. Eng. World, vol. 18, no. 6, June 1921, pp. 391–393. Investigations of advisory committee appointed by Bur. of Standards Reclamation Service, Drainage Investigations Office of Dept. of Agriculture and Portland Cement Assn.

Consistency. A Comparison of the Results of the Slump Test and the Flow Table in the Measurement of the Consistency of Concrete, W. L. Schwalbe. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 6 pp., 4 figs. It is concluded that relative consistencies are more truly indicated by flow table for greater range of consistencies than by slump test.

Crusher Screenings. Effect of Crusher Screenings in Concrete. Can. Engr., vol. 40, no. 21, May 26, 1921, pp. 500–502, 1 fig. Tests carried out by Milton Hersey Co., Montreal, for Crushed Stone Corporation Dundas, Ont. Increase in strength of concrete through use of up to 20 per cent of crusher screenings is reported.

Mixer. Pneumatic Concrete Mixer for Jap Tunnel. Public Works, vol. 50, no. 22, May 28, 1921, pp. 452–454, 1 fig. Special compressed-air machine designed for lining Imperial Japanese Government Railways tunnel.

Porete. Porete—A New Kind of Concrete, E. Walter. Concrete Products, vol. 20, no. 5, May 1921, pp. 19–21, 5 figs. Building product developed by Porete Mfg. Co. which is much lighter in weight than ordinary concrete, weighing from 50 to 55 lb. per cu. ft.

Proportioning Aggregates. A Proposed Method of Estimating the Density and Strength of Concrete and of Proportioning the Materials by the Experimental and Analytical Consideration of the Voids in Mortar and Concrete, Arthur N. Talbot. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 29 pp., 9 figs. Characteristic mortar curves giving relation between mortar voids and ratio of fine aggregate to cement, both for basic water content and for water contents in excess of this. Analytical relations developed from characteristic curves for determining proportions of cement, fine aggregate and coarse aggregate for concrete of required density and strength.

Sea-Water Action. Effect of Sea Water on Concrete Structures. Cement & Eng. News., vol. 33, no. 5, May 1921, pp. 29–30, 1 fig. Experience with piers at Annapolis Royal, Nova Scotia.

Specifications. German Specifications for Concrete (Die Gütevorschriften für Beton), B. Löser. Bauingenieur, vol. 2, no. 9, May 15, 1921, pp. 229–233, 5 figs. From results of investigations writer concludes that officially prescribed testing method for soft and liquid concrete is unsuitable and leads to false conclusions.

Strength. Effects of Organic Impurities on Concrete. Public Works, vol. 50, no. 21, May 21, 1921, pp. 425–426. Investigations at Lewis Inst., Chicago. Minute quantities of tannic acid reduce strength one half. Surface loam always reduces strength. From proceedings Am. Soc. for Testing Matls.

Testing. Report of Committee C-9 on Concrete and Concrete Aggregates. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 19 pp. Proposed tentative methods for making compression tests of cement concrete, test for organic impurities in sands, test for sieve analysis of aggregates, and for securing specimens of hardened concrete from structure; also proposed tentative specifications for concrete aggregates.

Tests. Influence of the Grain Composition of the Aggregates of Gravel-Concrete Mixtures on Compressive Strength and Elasticity (Der Einfluss der Kornzusammensetzung der Zuschlagstoffe von Kiesbeton-Mischungen auf die Druckfestigkeit und -Elastizität), Josef Kortlang. Bauingenieur, vol. 2, no. 9, May 15, 1921, pp. 239–243, 5 figs. Results of experiments show that compressive strength is dependent upon water cement and cement ratios and the total surface of aggregates per unit.

Water Content. Mathematical Determinations of Water Content of Mortars and Concrete. According to the New Theories on Their composition and on the Rôle Played by Their Various Elements (Le dosage mathématique, en eau, des mortiers et bétons, d'après les nouvelles théories sur leur composition et sur le rôle de leurs divers éléments), J. Boudet. Vie technique & industrielle, vol. 2, no. 19, April 1921, pp. 39–45, 4 figs. Graphs.

CONCRETE CONSTRUCTION

Developments. New Methods Relating to Concrete Construction. Concrete & Constructional Eng., vol. 16, no. 5, May 1921, pp. 311–317, 15 figs. Inventions relating to construction of walls, wall ties, slabs, etc.

Technology. Some Problems in Concrete Construction, W. K. Hatt. Mun. & County Eng., vol. 60, no. 5, May 1921, pp. 182–187. Review of principles developed from results of various investigators.

CONCRETE, REINFORCED

Wood Reinforcement. Wood Reinforcements of Cement (Le béton armé de bois), M. Levatel. Outillage, vol. 5, no. 10, Mar. 10, 1921, pp. 283–284, 10 figs. Experiments show that wood reinforcements are effective, wood being preserved perfectly for indefinite time.

CONDENSERS, STEAM

Water Films. The Water Film on Evaporating and Condensing Tubes, P. H. Parr. Engr., vol. 131, no. 3413, May 27, 1921, pp. 559–561. Internal resistance of water film.

CONDUITS

Steam Pipe. Steam Conduit for Toronto's New Union Station. Contract Rec., vol. 35, no. 22, June 1, 1921, pp. 551–552, 4 figs. Two pipe lines in concrete tunnel convey steam from power house, several blocks distant. Provision for removal of seepage.

CONNECTING RODS

Machining Operations. Machining Connecting Rods. Eng. Production, vol. 2, no. 35, June 2, 1921, pp. 681–683, 6 figs. Jigs and tools for accurate production.

Rolls-Royce. The Rolls-Royce Connecting Rods, Ferd H. Colvin. Am. Mach., vol. 54, no. 24, June 16, 1921, pp. 1041–1043, 7 figs. Machining methods.

COOLING TOWERS

New Type. A New Type of Water Cooling Tower. Beama, vol. 8, no. 5, May 1921, p. 418. Tower recently erected at government electric station in Dresden, Germany. Air and water do not flow on counter-current principle, but air enters cooler horizontally while water falls vertically.

COPPER

Thermal Expansion. Thermal Expansion of Copper and Some of Its Important Industrial Alloys, Peter Hidnert. U. S. Dept. of Commerce, Scientific Papers of Bur. of Standards, no. 410, Mar. 21, 1921, pp. 91–159, 43 figs. Data on thermal expansion of 128 samples of copper and its important industrial alloys of various compositions, heat treatments, mechanical treatments, etc. Samples were examined from room temperature to about 300 deg. cent.

CORES

Core Oils. Tests Show the Quality of Core Oils, R. F. Harrington. Foundry, vol. 49, no. 11, June 1, 1921, pp. 447–448, 3 figs. Tests used by manufacturers of core oil to determine character of various ingredients are described. Effect of core oil varied by use of dry or wet sand.

CORROSION

Iron in Concrete. The Corrosion of Iron and Steel with Special Reference to Reinforced Concrete, J. Newton Friend. Concrete Inst. Trans., vol. 9, Apr. 1921, pp. 1–15 and (discussion) pp. D15–D20, 3 figs. It is shown that preservation of iron in concrete may be effected in one or more of three ways, namely by complete exclusion of air, of water, and by rendering concrete sufficiently alkaline to place it within the protective area. Suggestions are offered.

CRANES

Locomotive. Electrically Driven Locomotive-Lifting Crane (Elektrisch betriebene Lokomotivhebekrane), Ernst Schwarz. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 22, May 28, 1921, pp. 574–576, 4 figs. Crane of Hungarian Car & Machine Factory in Györ and AEG Union Electrical Co., Vienna, consisting of two coupled traveling cranes, each having two hoist trolleys. Details of mechanical and electrical equipment; control; original form of connection plug.

CUTTING TOOLS

Design. Metal Cutting Tools—X and XI, A. L. DeLeeuw. Am. Mach., vol. 54, nos. 21 and 23, May 26 and June 9, 1921, pp. 897–902, 13 figs., and 985–990, 13 figs. May 26. Notes on design of milling cutters, gear cutters, duplex cutters and various types of hobs. June 9: Cutter sharpening; characteristics of cup and disk wheels; importance of correct angles; cutter grinders; hob grinding.

Working Pressures. Origin and Calculation of Working Pressure with Single-Cutter Tools Based on Results of Recent Experiments (Entstehung und Berechnung der Zerspannungswiderstände bei einschneidigen Werkzeugen auf Grund der Ergebnisse neuerer Versuchsreihen), Ernst J. Wild. Betrieb, vol. 3, no. 16, May 10, 1921, pp. 467–472, 5 figs. Critical investigation of results of experiments carried out in recent years on the behavior of single-cutter tools in turning and planing. Based on conclusions reached, new formulas are derived for the exact precalculation of the cutting forces, taking into consideration the shape of tool.

D

DIESEL ENGINES

Compression. The Compression Line in Diesel-Engine Cards (Ueber den Verlauf der Kompressionslinie bei Dieselmotoren), Arthur Balogh. Wirtschaftsmotor, no. 3, Mar. 1921, pp. 19–20, 8 figs. Results of experimental tests carried out on a single-cylinder Diesel engine to determine course of compression line of indicator cards.

Oil-Fuel Injection. Injection and Combustion of Fuel-Oil, C. J. Hawkes. Motorship, vol. 6, no. 6, June 1921, p. 483, 3 figs. Experiments with solid injection and air-blast in marine Diesel engines. (Continuation of serial.)

Standardization. Standardized Diesel Engines—IV, H. R. Setz. Mar. Eng., vol. 26, no. 6, June 1921, pp. 471–476, 11 figs. Description of engine with automatic valve-port scavenging arrangement.

Tar Oil as Fuel. The Use of Tar Oil in Diesel Engines (Die Verarbeitung von Teeröl im Dieselmotor), W. Riehm. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 20, May 14, 1921, pp. 522–526, 18 figs. Means whereby safe starting up of cold engine, reliable ignition and complete combustion under all load conditions can be obtained.

DRAWINGS

Filing. Indexing and Filing Industrial Drawings, L. H. Park. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1447–1449, 1 fig. Systems used by prominent engineers and manufacturers.

DREDGING

Tests. Tests of Dredge Pump Operation for Hydraulic Fill, Ivan E. Houk. Eng. News-Rec., vol. 86, no. 24, June 16, 1921, pp. 1034–1037, 3 figs. Velocities and power consumption decreased as friction head and solids increased.

DRILLING MACHINES

Radial. Carlton Heavy-Duty Ball Bearing Radial Drill Machine, J. V. Hunter. Am. Mach., vol. 54, no. 21, May 26, 1921, pp. 908–911, 6 figs. Heavy-duty, geared radial drilling machine made by Carlton Machine Tool Co., Cincinnati.

Tests. Investigations on Drilling Machines (Untersuchungen an Bohrmaschinen), S. ter Ohanessian. Werkstattstechnik, vol. 15, no. 9, May 1, 1921, pp. 241–244, 12 figs. Tests carried out at laboratory of Technical Academy of Charlottenburg with two motor-driven bench, two hand and one upright drilling machines, for determination of efficiency, etc.

DRILLS

Twisted vs. Twist. The Strength of Twisted Drills. Machy. (Lond.), vol. 18, no. 452, May 26, 1921, pp. 244–247, 15 figs. Data, comprising a series of micro-etchings and test results, obtained by J. Beardshaw & Sons, Ltd., Baltic Steel Works, Sheffield and representing outcome of extensive investigation to ascertain strength of twisted drills as compared with ordinary twist drills.

DROP FORGING

Plants. Fuel Economy of a Drop Forge Plant, N. A. Craigue and C. H. L. Thompson. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1521–1525, 6 figs. Tests on steam consumption of drop-forging hammers.

DUST

Cloud-Condensation Apparatus. The Shimizu-Wilson Cloud Condensation Apparatus. Engineering, vol. 111, no. 2892, June 3, 1921, p. 692, 2 figs. Apparatus for measuring dustiness of air.

E

EDUCATION, ENGINEERING

Industrial Training. Requirements of the Engineering Industries and the Education of Engineers, Magnus W. Alexander. Mech. Eng., vol. 43, no. 6, June 1921, pp. 391–395 and 397. Developments in organization of coöperative engineering courses in connection with manufacturing plants. Plan organized at Mass. Inst. of Technology and Lynn Works of Gen. Elec. Co. During their assignments at works, students are subject to usual rules and regulations applying to employees of Gen. Elec. Co.

EDUCATION, INDUSTRIAL

Steel Industry. Educational Work in the Wire Industry, Charles R. Sturdevant. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1460–1462. Courses

on salesmanship, Americanization and for foremen, being given by Am. Steel & Wire Co., Cleveland. Paper read before Am. Iron & Steel Inst.

ELECTRIC DRIVE

Air Compressors. Electrically Driven Centrifugal Compressors, R. S. Sage. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 559–553, 6 figs. Suitability of this load for central stations.

Motor Drives for Air Compressors, Gordon Fox. Power, vol. 53, no. 20, May 17, 1921, pp. 778–779, 3 figs. Types of air compressor, their limitations, power requirements and operating characteristics. Motors to use for different applications.

Slow Speed Motors and Their Application to Reciprocating Air Compressors, R. O. Joslyn. Armour Engr., vol. 12, no. 4, May 1921, pp. 226–239, 6 figs. Operation characteristics of typical installation.

Flour Mills. Electric Drive for Flour and Grist Mills, W. T. Edgell, Jr. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 542–546, 3 figs. Operating data obtained in existing installations.

Machine Shops. Electric Drive for Machine Shops, B. S. Pero. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 528–529, 2 figs. Types of motors used.

Machine Tools. Installation of Motor Drives on Old Tools, J. H. Vincent. Am. Mach., vol. 54, no. 23, June 9, 1921, pp. 100–1001, 3 figs. Expedients resorted to in railroad shop to provide individual motor drive for old planer and boring mill.

Oil Fields. Extension of Electric Power Service Into the Oil Fields, W. G. Taylor. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 535–538, 5 figs. Survey of developments.

Refrigerating Plants. Refrigeration Load. A. R. Stevenson, Jr. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 569–571, 2 figs. Typical load curves of ice plants.

Rolling Mills. Sheet Rolling Mills at Baltimore. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1535–1538, 7 figs. Top rolls of roughing mills driven by independent motor.

Skip Hoists. Electric Drive for Small Automatic Self-Dumping Skip Hoists, R. H. McLain and C. B. Connely. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 530–535, 13 figs. Notes on design of installations.

Steel Mills. Blooming Mill Motor Drive, B. M. Jones. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1386–1387, 2 figs. Replacing steam by electric drive on large reversing blooming mill at plant of Bethlehem Steel Co.

Load Conditions in Steel Mills, J. D. Wright and L. C. Moseley. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 487–490, 8 figs. Typical load curves.

Woodworking Industry. Motor Drive in the Woodworking Industry, F. H. Penney and E. L. Bamforth. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 554–557, 5 figs. Types of electrically driven machines used in wood-working industry.

ELECTRIC FURNACES

Crucible vs. Electric vs. Crucible Furnaces. H. W. Gillet and T. H. A. Eastick. Metal Industry (N. Y.), vol. 19, no. 6, June 1921, pp. 240–242. Opinions of Bur. of Mines experts on opposite sides of question.

ELECTRIC PLANTS

Interconnection. Interconnection Problems and Economies, E. P. Peck and Harry J. Burton. Elec. World, vol. 77, no. 22, May 28, 1921, pp. 1238–1240. Symposium. Titles of papers are: Charts for Quick Solution of Line-Drop Problems; Conditions that Must Be Watched When Inter-connecting Small Plants; and Economic Benefits Derived from Energy Interchange.

Protective Equipment. Protection of Power-Station Equipment, Edgar P. Slack. Power, vol. 53, no. 23, June 7, 1921, pp. 920–923, 3 figs. National Electrical Code as applied to power-station equipment.

ELECTRIC WELDING

Cast Steel. Repairing a Gold Dredge Bull Gear, C. M. Romanowitz. Eng. & Min. Jl., vol. 111, no. 25, June 18, 1921, pp. 1030–1031, 3 figs. Repairing cast-steel gear of about 14 ft. 2 in. in diameter and 15-in. face.

ELECTRIC WELDING, ARC

Automatic. Automatic Arc Welding, H. L. Unland. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 583–586, 5 figs. Apparatus developed for automatic welding by electric arc.

Kjellberg Process. Electric Arc Welding (La soudure électrique à l'arc), M. Lebrun. Revue de Métallurgie, vol. 18, no. 4, April 1921, pp. 201–212, 11 figs. Tests of Kjellberg process at Naval College of Greenwich by Anglo-Swedish Elec. Welding Co. Kjellberg process consists in stabilizing direction of arc by surrounding electrode with non-conducting slightly fusible material. Arc is thus prevented from flickering.

ELECTRIC WELDING, RESISTANCE

Modern Machines. Recent Progress in the Construction of Electric Welding Machines (Neuere Fortschritte im Bau elektrischer Schweissmaschinen), Albert Neuburger. Werkstattstechnik, vol. 15, no. 9, May 1, 1921, pp. 250–255, 8 figs. Details of various improved types of machines for spot, butt and seam welding.

Tests. Resistance Electric Welding (La soudure électrique par résistance), J. Paturel. Vie technique & industrielle, vol. 2, nos. 19 and 20, April and May 1921, pp. 24–26, 5 figs., and 137–139, 11 figs. Tests on aluminum and steel articles.

ENAMELS

Copper. Some Data on the Composition of Arsenic Enamels for Copper, B. T. Sweely. Jl. Am. Ceramic Soc., vol. 4, no. 5, May 1921, pp. 350–356. Methods of application by wet slushing.

EVAPORATORS

Regenerative Compressor. G-R Regenerative Compressor. Power, vol. 53, no. 20, May 17, 1921, p. 777, 1 fig. Apparatus designed for installation on Reilly evaporators. Compressor is essentially jet flow compressor that entrains and compresses by means of live steam part of vapor produced by evaporator, and this entrained vapor is in turn led to evaporator coils together with boiler steam.

F

FABRICS

A.S.T.M. Committee Report. Report of Committee D-13 on Textile Materials. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 8 pp. Proposed tentative definitions of terms relating to mechanical fabric and proposed tentative specifications for imperfections and tolerances for square-woven tire builder fabric.

FACTORIES

Building Construction. Can I Put Up That Building More Cheaply? J. Morrow Oxley. Contract Rec., vol. 35, no. 9, Mar. 2, 1921, pp. 218–222, 8 figs. Cost analysis of structural design of standard factory type.

FACTORY MANAGEMENT.

See INDUSTRIAL MANAGEMENT.

FANS, CENTRIFUGAL

Design. Some Developments in Centrifugal Fan Design, F. W. Bailey and A. A. Criqui. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 4, May 1921, pp. 375–380, 7 figs. Comparison of static efficiencies of forward and double-curved-blade types of fans.

FATIGUE

Industrial. Fatigue and Efficiency in Iron and Steel Works—VII, H. M. Vernon and E. A. Rusher. Eng. & Indus. Management, vol. 5, no. 18, May 5, 1921, pp. 519–522. Health of steel workers. Abstract from Report No. 5 of British Indus. Fatigue Research Board.

Fatigue in the Boot and Shoe Industry, J. Loveday and S. H. Munro. Eng. & Indus. Management, vol. 5, no. 19, May 12, 1921, pp. 541–543, 10 figs. Records given in report to British Indus. Fatigue Research Board.

FIREBRICK

Spalling. Report of Committee C-8 on Refractories. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 4 pp. Proposed tentative method of test for resistance of fireclay brick to spalling action.

FLAX

Scutching Machine. Flax Scutching Machine. Engineering, vol. 111, no. 2890, May 20, 1921, pp. 614–616, 7 figs. Combined flax-breaking and scutching machine invented by M. Swynghedauw of Motteville, France.

FLOW OF OIL

Pipes. The Flow of Petroleum Oils Through Pipes, W. A. Thomas. Oil News, vol. 9, no. 10, May 20, 1921, pp. 33–34. Tables of coefficients in formulas.

FLUE-GAS ANALYSIS

Excess-Air Determination. Determination of Excess Air from Flue Gas Analysis, R. Brown. Combustion, vol. 4, no. 6, June 1921, pp. 24–25, 2 figs. Chart and derivation of formula used in making it.

FORGE PLANTS

Erie. War Plant of Erie Forge & Steel Co., Sidney G. Koon. Iron Age, vol. 107, no. 24, June 16, 1921, pp. 1595–1603, 12 figs. Plant developed and built by U. S. Navy Dept. under emergency legislation of Oct. 1917.

FOUNDRIES

Layout. Completes Revision of Foundry, George H. Manlove. Foundry, vol. 49, no. 11, June 1, 1921, pp. 426–429, 8 figs. Layout of Chicago Steel Foundry Co. providing for straight-line traveling of products.

Power Plants. Power for the Toledo Machine and Tool Co. Power Plant Eng., vol. 25, no. 12, June 15, 1921, pp. 595–599, 8 figs. Plant furnishes power, light and heat necessary for operation of large foundry.

FUELS

Garbage. The Economic Utilization of House Garbage as Fuel (Die Vorbedingungen für die wirtschaftliche Verwertung des Hausmülls als Brennstoff), Jakob Bodler. Zeit. des Bayerischen Revisions Vereins, vol. 25, nos. 7 and 8, Apr. 15 and 30, 1921, pp. 49–52 and 57–62, 5 figs. Suggestions for preliminary treatment of garbage with view to obtaining a good combustion.

FURNACES

Flame Propagation. Examination of Theory of Flame Furnaces Based on Laws of Hydraulics (Essai d'une théorie des fours a flammes basée sur les lois de l'hydraulique), W. E. Groume Grjimailo. Revue universelle des Mines, vol. 9, no. 2, April 15, 1921, pp. 132–144, 15 figs. Fundamental idea is that circulation of flames in furnace is identical with movement of light liquid in heavy liquid.

G

GAGES

Screw. The Manufacture of Hardened Screw Gauges. Eng. Production, vol. 2, no. 34, May 26, 1921, pp. 644–645, 3 figs. Machines and processes employed.

GAS ENGINES

Measurement of Gas and Air. Measurement of the Suction Gas and Air Volumes in Gas Engines (Messung der von Gasmaschinen angesaugten Gas- und Luftmengen), K. Schreber. Oel- u. Gasmaschine, vol. 18, no. 5, May 1921, pp. 72–73. Results of investigation show that, with use of certain precautionary measures, it is possible with aid of a nozzle to carry out measurements for determining economy of gas engines.

GASOLINE

Cracking Processes. Manufacture of Motor Spirit by "Cracking" Processes. Chem. Age (Lond.), vol. 4, no. 101, May 21, 1921, pp. 578–580. Manufacture of gasoline by pyrolitic decomposition of higher boiling hydrocarbons.

Specifications. Report on Low Test Gasoline Specifications. U. S. War Dept., Air Service Information Circular, vol. 2, no. 165, May 1, 1921, 4 pp.

GEARS

Blank Manufacture. An Improved Method of Making Steel Gear and Wheel Blanks, George Atwell Richardson. Am. Mach., vol. 54, no. 23, June 9, 1921, pp. 981–984, 13 figs. Manufacture of high-grade steel gear blanks in hydraulic ram for production work.

Design. Odontograph for Layout of 20-Degree Gear Teeth, J. L. Williamson. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 929, 1 fig. Table giving calculated valuation of constant.

Involute. Slip of Involute Gear Teeth. A. B. Cox. Am. Mach., vol. 54, nos. 21 and 22, May 26 and June 2, 1921, pp. 913–917, 4 figs., and 951–955, 9 figs. Gear efficiency increased and wear decreased by using large numbers of teeth. Shorter addendum reduced slip. Friction losses increase with increases in angle of obliquity. Graphs. Diagrams for internal-gear formulas. (To be continued.)

The Evolution of the Involute Gear Tooth—V, A. Fisher. Machy. (Lond.), vol. 18, no. 453, June 2, 1921, pp. 273–276, 8 figs. Study of contact conditions.

Laminated. The Manufacture of Laminated Gears. Eng. Production, vol. 2, no. 34, May 26, 1921, pp. 653–655, 7 figs. Practice at works of Laminated Gears, Ltd., Sheffield, England.

Machining Operations. Machining a Large Gear Blank on the Automatic, J. H. Moore. Can. Machy., vol. 25, no. 21, May 26, 1921, pp. 71–74, 12 figs. Attachments used. Tool layouts for gear blanks, hubs and spark-plug shells.

Spiral. Chart for Selecting Spiral Gears. Machy. (Lond.), vol. 18, no. 449, May 5, 1921, pp. 141–143, 1 fig. Chart prepared from standard formulas.

GRINDING MACHINES

Cylinder. Cylinder Grinding Machine. Engineering, vol. 111, no. 2892, June 3, 1921, pp. 676–678, 20 figs. Machines manufactured by Heald Machine Co., Worcester, Mass.

GUN METAL

Properties. Reviews Properties of Gunmetal, Joseph Horton. Foundry, vol. 49, no. 11, June 1, 1921, pp. 436–439. Compositions and physical properties called for in different specifications are compared and views of number of investigators on effects of various metals and heat treatments are cited.

GUNS

Radially Expanded. Elastic Strength of Radially Expanded Guns, W. H. P. Blandy. U. S. Naval Inst. Proc., vol. 47, no. 220, June 1921, pp. 883–908, 14 figs. Process of gun construction by radial expansion was described in U. S. Naval Inst. Proc. for Dec. 1920. In present article elastic strength of radially expanded gun is computed analytically and compared with similarly computed strengths of other guns.

H

HANGARS

Reinforced-Concrete. Reinforced Concrete Hangars. Concrete Constructional Eng., vol. 16, no. 5, May 1921, pp. 318–320, 4 figs. Hangar recently built at Lucon Vendée, France. Design consists of arch 176 ft. high internally, 186 ft. externally, 362 ft. wide and 733 ft. long. Translated from Génie Civil.

HEAT TRANSMISSION

Research. Apparatus for Testing Insulating Materials, F. B. Rowley. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 469–474, 8 figs. Adaptations of hot-box methods of testing heat transmission.

Heat Transmission Investigations, A. J. Wood and E. F. Grundhofer. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 453–462, 1 fig. Results of study and experimentation on heat transmission through corkboard and air spaces. Work undertaken at Engineering Experiment Station, Pennsylvania State College.

HEATING, ELECTRIC

Factories. Air Heating by Electricity in Swiss Fac-

tory (Réchauffeur d'air électrique, à accumulation). Génie Civil, vol. 78, no. 18, April 30, 1921, pp. 376–377, 2 figs. Heater has capacity of 3300 kw.

HEATING, GAS

Coal versus. The Application of Gas to Space Heating, Thomson King. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 421–434, 10 figs. Comparative costs of heating by gas and by coal.

HEATING, HOT-WATER

Piping. Circulation Problems in Hot-Water Heating, A. W. Luck. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 409–416, 7 figs. Typical piping methods.

HEATING, STEAM

Gravity Systems. Fractional Distribution in Two Pipe Gravity Steam-Heating Systems, Alphonse A. Adler and James A. Donnelly. Jl. Am. Soc. Heat & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 437–452, 4 figs. Typical devices for gravity return.

HOISTING ENGINES

Mine. A Large American Mine Winding Engine. Engr., vol. 131, no. 3412, May 20, 1921, pp. 540–542 and 544, 7 figs. Four-cylinder cross-compound condensing machine with drum 30 ft. diameter for raising 10-ton loads with rope speed of 3200 ft. per min. from depths of 6600 ft. to 8600 ft.

HOUSES

Stucco. Back-Plastered Stucco House Construction Concrete, vol. 18, no. 6, June 1921, pp. 274–278, 12 figs. Recommendations prepared by Committee of Am. Concrete Inst.

HOUSES, CONCRETE

Economic Construction. "Double C" Elements for Economic Construction of Buildings (Agglomérés en éléments dits "double C" pour la construction economique des bâtiments). Génie Civil, vol. 78, no. 18, April 30, 1921, p. 379, 3 figs. Concrete slabs with projecting members. In erecting wall projecting members are placed end to end and fastened together by suitable reinforcing bar.

England. The Development of Concrete for Housing in England. Concrete, vol. 18, no. 6, June 1921, pp. 279–281, 6 figs. Systems of constructing cavity walls. From Concrete & Constructional Eng.

Unit Dwellings. The One-Piece House, Harry A. Mount. Sci. Am., vol. 124, no. 22, May 28, 1921, pp. 424–425, 4 figs. Simon Lake's scheme for producing ready-to-live-in concrete unit dwellings and transporting them to site.

HOUSING

Industrial. The Present Housing Crisis and Suggested Way Out, John Ihlder. Jl. Engrs. Club of Phila., vol. 38, no. 197, May 1921, pp. 210–205. Government house building in England adopted as necessary for future. Political and economic aspect of housing shortage in U. S.

Mines. Rosita, Mexico, a Carefully Planned City; Pleasing, Comfortable and Hygienic—I, Hjalmar E. Skougor. Coal Age, vol. 19, nos. 22 and 23, June 2 and 9, 1921, pp. 983–987, 8 figs., and 1037–1040, 9 figs. Village for employees at coal mines and by-product plant of Am. Smelting & Refining Co. Each family to have lot 50 ft. square and share in a large community farm.

HYDRAULIC TURBINES

Design. A New Type of Water Turbine. Engr., vol. 131, no. 3411, May 13, 1921, pp. 518–519, 6 figs. Suggests use of continuously curved inner and outer surfaces of revolution for turbine water passages, thus avoiding all sudden changes of curvature.

Calculation of the Moment of Inertia of the Flywheel of a Hydraulic Turbine (Calcul du moment d'inertie a donner aux volants des turbines hydrauliques), P. Cayère. Houille Blanche, vol. 20, no. 51–52, Mar.-April 1921, pp. 57–63, 10 figs. Formulas and graphs.

Governors. Improvements in Hydraulic Turbines, H. Donath. (Neuerungen an Wasserturbinen), Elektrotechnischer Anzeiger, vol. 38, nos. 69–70, 71 and 72, May 4, 5 and 7, 1921, pp. 439–442, 447–448 and 453–455, 17 figs. Details of regulating devices.

Regulation. Regulation of Hydraulic Turbines (Les turbines hydrauliques et leur régulation). Revue genérale de l'Électricité, vol. 9, no. 18, April 30, 1921, pp. 616–623, 7 figs. Survey of developments. (Abstract.) Paper read before Société des Ingénieurs civils de France.

HYDROELECTRIC PLANTS

Canada. Hydroelectric Plant at Weedon, P. Q., for City of Sherbrooke. Elec. News, vol. 30, no. 10, May 15, 1921, pp. 30–31, 3 figs. Plant will develop 4000 hp. and deliver energy at 50,000 volts along transmission line 28 mi. long.

Design. Hydro-Electric Practice—Features of Design, C. Voetsch. Power, vol. 53, no. 21, May 24, 1921, pp. 818–823, 12 figs. Overall efficiency of hydroelectric power system. Effects of main unit sizes upon station efficiency. Importance of specific speed in turbine design. Curves given for checking turbine design or laying out preliminary designs.

Efficiency. How to Increase the Efficiency of Existing Water-Power Plants, Charles M. Allen. Jl. Worcester Polytechnic Inst., vol 24, no. 3, April 1921, pp. 192–200, 1 fig. Graph showing best speed for maximum horsepower at any gate for heads from 25 ft. to 33 ft.

Hydraucone Regainer. The Hydraucone Regainer, Its Development and Applications in Hydroelectric Plants, W. M. White. Mech. Eng., vol. 43, no. 6, June 1921, pp. 375–380 and 419, 17 figs. Device for recovering energy discharged from runner for useful effect on water wheel within limited space available in power-house foundations. Method consists in causing stream flow to impinge upon flat, conical or concave shape, thus changing its direction, and then by means of a gradual diverging envelope placed around this shape to change the velocity head of a fluid entering at high velocity into pressure and low velocity at exit. Results of tests are included.

Spain. Hydroelectric Plants of Guadiaro River, Spain (Les usines hydro-électriques du Guadiaro), Adolphe Weber. Schweizerische Bauzeitung, vol. 77, no. 23, June 4, 1921, pp. 257–258, 4 figs. Corshado plant utilizing waterfall of 120 m. (To be continued.)

Sweden. High Power Hydroelectric Installations (Installations hydro-électriques de grande puissance), A. Tétrel. Electricien, vol. 37, no. 1277, June 1, 1921, pp. 241–247, 9 figs. Central station at Trollhättan, Sweden. (To be continued.)

Underground. An Underground Hydroelectric Plant (Un cas particulier d'usine hydroélectrique souterraine), Paul Basiaux. Revue générale de l'Électricité, vol. 9, no. 19, May 7, 1921, pp. 656–657, 1 fig. Tunnel was constructed for diverting flow of water from Diege River, affluent of Dorgogne in France. Total energy utilized is 200,000 hp.

Water-Main Operation. Hydro-Electric Unit Operated from City Water Main, J. B. Holdcroft. Contract Rec., vol. 35, no. 9, Mar. 2, 1921, pp. 207–210, 4 figs. Installation at Port Alberni, B. C., where high pressure and large pipe capacity permitted water-wheel attachment, operating civic lighting plant.

HYDROGLIDERS

Theory. The Hydroglider—Its Theory and Its Future (L'hydroglisseur, sa théorie, son avenir), F. de Pierrefeu. Vie technique & industrielle, vol. 2, no. 18, Mar. 1921, pp. 511–517, 10 figs. Boat gliding along surface of water by action of air propeller.

I

ICE PLANTS

Toronto. Producing Ice in an Up-To-Date Plant, T. H. Fenner. Power House, vol. 14, no. 8, April 20, 1921, pp. 21–24, 7 figs. Toronto plant with output of 80 tons per day.

IGNITION

Theory. Underlying Principles of Electrical Ignition, Benjamin F. Bailey. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 570–576 and 607, 8 figs. Formulas and graphs expressing variations in energy supplied by magneto, produced by changes in engine speed.

INDUSTRIAL MANAGEMENT

Chart of. The Chart of Scientific Management, Robert Stelling. Eng. & Indus. Management, vol. 5, no. 22, June 2, 1921, pp. 622–623, 1 fig. Methods by which economic waste can be eliminated.

Control of Functions. The Control of Function in Industry. Eng. & Indus. Management, vol. 5, no. 21, May 26, 1921, pp. 597–599. Essential features to be considered when planning a scheme for controlling functions, or duties, of a worker in large organization.

Distribution of Work. Factory Management (Die Betriebsleitung des Grossbetriebes), Gustav Wedemeyer. Betrieb, vol. 3, no. 16, May 10, 1921, pp. 482–483. Notes on distribution of work among executive heads.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter), Betrieb, vol. 3, no. 16, May 10, 1921, pp. 120–121. Proposal of Works Department of German Federation of Technical and Scientific Societies for instruction sheet for installation and care of transmissions; and for fire-prevention measures.

Measurement of Labor Losses. Production Hours —A New Measure of Management, William Leavitt Stoddard. Factory, vol. 26, no. 11, June 1, 1921, pp. 1287–1291, 1 fig. Plan for accurate measurement of labor losses.

Production Systems. Modern Production Methods —XVII, W. R. Basset. Am. Mach., vol. 54, no. 24, June 16, 1921, pp. 1032–1036, 4 figs. Illustrates method of handling abnormal expense.

Planning and Controlling Production in a French Shop, E. Julien. Am. Mach., vol. 54, no. 21, May 26, 1921, pp. 889–893, 13 figs. Engineering department responsible for bills of material. Cylindrical control board saves room. Calculagraph used in work-distributing department.

Routing Materials. Works Administration, Cecil F. Hammond. Eng. Production, vol. 2, no. 34, May 26, 1921, pp. 647–652, 11 figs. Progress system and its relation to works costing.

[See also TIME STUDY.]

INSPECTION

Systems. The Delco Inspection System, Louis Ruthenburg and R. A. Crist. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 921–926, 4 figs. Methods used by Dayton Eng. Laboratories Co., for inspection of raw materials, purchased parts, tools, equipment and gages, and manufactured product.

INTERNAL-COMBUSTION ENGINES

Cylinder Actions. Cylinder Actions in Gas and Gasoline Engines, Dugald Clerk. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 523–539, 24 figs. Account of experiments which have been made to develop theory and establish property of flame-working fluid in internal-combustion engines. Description of Clerk plane-pressure starter.

Detonation. Detonation in Internal-Combustion Engines, H. T. Tizard. Eng. & Indus. Management, vol. 5, no. 18, May 5, 1921, pp. 515–518. Conditions under which different types of fuel ignite. (To be continued.)

The Causes of Detonation in Internal-Combustion Engines, H. T. Tizard. North-East Coast Instn. Engrs. & Shipbuilders, advance paper, 21 pp., 16 figs. From Technical considerations and experimental evidence it is concluded that detonation depends not only on ignition temperature but also on maximum flame temperature and effect of temperature on rate of combustion.

Fuels. The Influence of Various Fuels on the Performance of Internal Combustion Engines—V, H. R. Ricardo. Automobile Engr., vol. 11, no. 151, June 1921, pp. 201–205, 9 figs. Tests on variable compression engines. It was found that when both change in specific heat and dissociation are taken into account maximum temperature obtained with economical mixture strengths is substantially the same of all available hydrocarbon fuels, though it is perceptibly lower in case of alcohol; also that gain in efficiency with increase in compression ratio is very considerably greater than is required by air cycle formula.

Temperature-Entropy Diagrams. Temperature Entropy Diagrams for Gas and Oil Engine Cycles, Guy B. Petter. Engineering, vol. 111, no. 2892, June 3, 1921, pp. 669–670, 9 figs. Examples of method of constructing diagram and notes on its interpretation.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES, DIESEL ENGINES; GAS ENGINES; OIL ENGINES, SEMI-DIESEL ENGINES.]

IRON

Basic Open-Hearth. Commercially Pure Iron in the Basic Open-Hearth, W. J. Beck. Chem. & Metallurgical Eng., vol. 24, no. 22, June 1, 1921, pp. 965–968, 3 figs. Notes on development of metallurgical process for producing substantially pure ferrite on tonnage basis, without containing excessive amount of gas. Many modifications in rolling mills and galvanizing department were necessary to make finished sheets. Paper read before Am. Iron & Steel Inst.

Pure Iron from Basic Open-Hearth Furnaces, W. J. Beck. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1462–1464, 3 figs. History of developments in production of very low carbon-manganese metal in open-hearth furnaces. Photomicrographs of ingot iron. Paper read before Am. Iron & Steel Inst.

The Development of Commercially Pure Iron in the Basic Open-Hearth Furnace, W. J. Beck. Am. Iron & Steel Inst., advance paper, May 27, 1921, 14 pp., 6 figs.

Electrolytic. "Slip-Lines" and Twinning in Electro-Deposited Iron, W. E. Hughes. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 7, 9 pp., 10 figs. Photomicrographs of etched sections of electrolytic iron, deposited under various conditions, are shown. It is suggested that slip lines are produced in grains by forces of contraction that act during formation.

Oxygen Solution. Cupric Etching Effects Produced by Phosphorus and Oxygen in Iron, J. H. Whiteley. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 12, 13 pp., 10 figs. Investigations to determine whether cupric reagents would detect small variations of phosphorus content synthetically produced in samples of electrolytic iron, also variations of oxygen content produced in iron samples.

Solid Solution of Oxygen in Iron, J. E. Stead. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 10, 5 pp., 5 figs. It is concluded from experiments that when iron is heated in air or oxidizing gases surface layers absorb oxygen which passes into solid solution. When supersaturated oxide falls out of solution, forming separate globules of free oxide which eventually join to form continuous layers.

IRON CASTINGS

Ice Machines. Making Castings for Ice Machines. Foundry, vol. 49, no. 11, June 1, 1921, pp. 419–425, 11 figs. Dense gray castings produced with iron phosphorus. Foundry of York Mfg. Co., York, Pa.

IRON INDUSTRY

Russia. The Russian Coal and Iron Industry, V. Gudkov. Min. & Metallurgy, no. 174, June 1921, pp. 10–13, 2 figs. Location, size and development of iron and coal fields, blast-furnace practice and special features of iron and steel industry.

J

JIGS

Design. Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach., vol. 54, nos. 21–24, May 26, June 2, 9 and 16, 1921, pp. 905–908, 10 figs., 939–942, 7 figs., 997–999, 7 figs. and 1037–1040, 9 figs. May 26: Design of drill jigs, leaf jigs, clamps, etc. June 2: Typical design of jigs and components; standardization of jig posts and thumb screws. June 9: Bushings. June 16. Drill templets and plate jigs.

L

LABOR

Spain. Labor Unrest in Spain, Anice L. Whitney.

U. S. Dept. of Labor, Monthly Labor Rev., vol. 12, no. 5, May 1921, pp. 154–165. Labor problem presents serious and even menacing possibilities because of revolutionary tendencies of large part of organized labor movement.

LABORATORIES

Aerodynamic. The Adlershof Altitude Testing Plant (Der Aldershofer Höhenprüfstand), K. Fr. Nägele. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 9, May 17, 1921, pp. 129–132, 5 figs. Consists of vacuum chamber with cradle dynamometer; cooling plant with pumps and re-cooling apparatus; motor-driven blowers; motor installation room with small workshop; refrigerating plant for furnishing of cold air; and room for attendants and instruments.

The Depression Chamber at Friedrichshafen (La chambre a depression de Friedrichschafen), G. Gilles. Aeronautique, no. 23, April 1921, pp. 177–179, 4 figs. Aeronautical laboratory chamber for testing machines in rarefied atmosphere.

Industrial. A Modern Works Laboratory. Eng. Production, vol. 2, no. 33, May 19, 1921, pp. 620–622, 10 figs. Details of new laboratory buildings and equipment erected and installed by the Rudge-Whitworth, Ltd., adjacent to firm's ball-bearing works at Sparkhill, Birmingham. Describes new measuring instruments, including the millimike, measuring sizes within capacity of micrometer to within 0.00001 in.; the pyromike, an optical pyrometer for measuring all temperatures from red heat upwards; and oxyscope, for measuring effects of oxidizing and reducing furnace gases upon various metals.

LATHE TOOLS

Circular Forming Tools. Circular Forming Tools (Rundstähle), Richard Nerrlich. Werkstattstechnik, vol. 15, nos. 8 and 9, Apr. 15 and May 1, 1921, pp. 212–217 and 244–250, 50 figs. Advantages of circular over straight forming tools.

LATHES

Automatic. The Herbert Auto-Lathe. Engr., vol. 131, no. 3413, May 27, 1921, pp. 574–575, 4 figs. Automatic lathe manufactured by Alfred Herbert, Coventry, England.

The Schütte Four Spindle Automatic Lathe (Der Schütte-Vierspindel-Automat). Der praktische Maschinen-Konstrukteur, vol. 54, no. 18, May 5, 1921, pp. 77–80, 7 figs. Machine brought out by Alfred H. Schütte, Cologne-Deutz, in 1915, which is claimed to surpass any known American types, and is especially adapted to quantity production of parts.

Precision Bench Lathes. Tools and Methods for Manufacturing Precision Bench Lathes—II, Machy. (Lond.), vol. 18, no. 451, May 19, 1921, pp. 204–207, 9 figs. Machining and inspection methods used in manufacture of T.L.M. bench lathe.

LIGNITE

Briquetting Plants. Modern Lignite Briquetting Plants (Einige neuzeitliche Braunkohlen-Brikett-erzeugungsanlagen), B. Schapira. Feuerungstechnik, vol. 9, nos. 13 and 14, Apr. 1 and 15, 1921, pp. 113–117 and 125–129, 19 figs. Briquet factories constructed by the Zeitz Iron Foundry and Machine Constr. Corp., Germany.

LIME

A.S.T.M. Committee Report. Report of Committee C-7 on Lime. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 32 pp., 1 fig. Specifications for finishing hydrated lime. Comparative tests on effect of hydrated lime on concrete mixtures. Specifications for quicklime for structural purposes. Chemical analysis of limestone, lime and hydrated lime.

LOCOMOTIVE BOILERS

Stay Heads. Renewable Stay Heads for Locomotive Fireboxes. Ry. Engr., vol. 42, no. 496, May 1921, pp. 165–168, 8 figs. Stay heads adopted by London & North Western, Ry.

LOCOMOTIVES

British. Recent British Locomotives for Home and Foreign Service. Ry. Engr., vol. 42, no. 496, May 1921, pp. 175–181, 11 figs New three-cylinder express locomotives used by Great Northern & North Eastern Ry.

Coal Economy. Measures of the Austrian Federal Railway for Reducing the Coal Consumption of Steam Locomotives (Massnahmen der oesterreichischen Bundesbahnen zur Verminderung des Kohlenverbrauches der Dampflokomotiven), J. Rihoschek. Zeitung des Vereins Deutscher Eisenbahnverwaltungen, vol. 61, no. 17, Apr. 28, 1921, pp. 322–323. Account of tests carried out by State Railway Administration. (Abstract.)

Consolidation Type. Consolidation Type Locomotives for the Western Maryland Railway. Ry. & Locomotive Eng., vol. 34, no. 6, June 1921, pp. 164–165, 2 figs. Characteristics: Cylinders, 27 in. by 32 in.; boiler diameter, 88 in.; working pressure, 210 lb. per sq. in.; total heating surface, 3498 sq. ft.; superheater, 945 sq. ft.; diameter of driving wheels, 61 in. Table is included showing comparison with others of heavy consolidation type built by Baldwin Locomotive Works.

High-Capacity. Vitalizing Locomotives to Improve Operation, George M. Basford. Ry. Age, vol. 70, no. 21, May 27, 1921, pp. 1227–1231, 5 figs. Increasing capacity of locomotive suggested as means to meet present conditions successfully.

Internal-Combustion. Modern Internal-Combustion Locomotives (Moderne Motorlokomotiven), H. Sorg. Oel- u. Gasmaschine, vol. 18, no. 5, May, 1921, pp. 73–76, 4 figs. Details of locomotives built by Orenstein & Koppel Corp., Montania Department, Nordhausen, Germany.

Mallet. New Mallets and Switchers, Chesapeake & Ohio Ry., Jno. R. Gould. Railroad Herald, vol. 25, no. 6, May 1921, pp. 21–23, 2 figs. Economical advantages of Mallet type of locomotive.

Mine. Compressed-Air Mine Locomotive (Locomotive de mines, à air comprimé), L. Pierre-Guiédon. Génie Civil, vol. 78, no. 15, April 9, 1921, pp. 312–315, 6 figs. Leroux type permitting triple expansion and energy regeneration.

Oil-Burning. Oil Burning Express Locomotives, Highland Railway. Ry. Gaz., vol. 34, no. 19, May 13, 1921, pp. 726–727, 5 figs. Adoptation of Scarab system to engines of 4-6-0 type.

Pressure on Rails. Note on the Determination of the Stresses at the Point of Contact Between the Tire of a Locomotive Wheel and the Head of the Rail, R. Desprets. Bul. Int. Ry. Assn., vol. 3, no. 5, May 1921, pp. 507–511, 2 figs. Formulas for calculating stresses.

LUBRICATING OILS

Air Compressors. Lubricating Oils for Diesel-Engine Air-Compressors. Motorship, vol. 6, no. 6, June 1921, p. 474. Specifications regarding oils suitable for use for lubricating air compressors adopted by Diesel Engine Users Assn.

Viscosity. The Effect of Crystalline Paraffin Wax Upon the Viscosity of Lubricating Oil, E. W. Dean and L. E. Jackson. U. S. Dept. of Interior, Reports of Investigations, Bur. of Mines, serial no. 2249, May 1921, 3 pp. Changes on content of paraffin wax up to maximum of approximately 9 per cent cause negligible variations in viscosity of two Pennsylvania lubricating oil fractions through considerable range of temperature.

LUBRICATION

Marine Turbines. The Lubrication Problem on Shipboard, P. M. Robinson. Mar. Eng., vol. 26, no. 6, June 1921, pp. 458–462, 6 figs. Oiling system recommended by Westinghouse Elec. & Mfg. Co. for geared-turbine equipment.

M

MACHINE SHOPS

Automobile. Special Machines and Fixtures in the Franklin Plant. Machy. (Lond.), vol. 18, no. 451, May 19, 1921, pp. 193–199, 19 figs. Mechanical equipment designed either to increase production, perform special operations, or maintain established standards of accuracy, in different departments of plant in Syracuse.

Design. A Monitor-Type Shop for Building Lathes, Fred H. Colvin. Am. Mach. vol. 54, no. 24, June 16, 1921, pp. 1030–1031, 6 figs. Monitor type of building with slanting sides and all roof drainage towards center of building.

MACHINE TOOLS

Oil-Grooving Machine. The Haigh Oil-Grooving Machine. Machy. (Lond.), vol. 18, no. 452, May 26, 1921, pp. 234–235, 3 figs. Machine recently developed for rapidly cutting external or internal oil grooves in shafts and bearings.

MALLEABLE CASTINGS

Motorcycles. From the Foundry to the Speedway, Herbert R. Simonds. Foundry, vol. 49, no. 12, June 15, 1921, pp. 459–462, 11 figs. Malleable parts used in motorcycles are brazed to steel tubing. Practice of Hendee Mfg. Co. Springfield, Mass.

MALLEABLE IRON

Melting Furnaces. American Malleable Cast Iron—XII, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 24, June 16, 1921, pp. 1662–1668, 5 figs. Types of air furnaces for melting malleable iron.

MANOMETERS

Differential. Report to Committee of Mechanical Arts on Gaging Apparatus of M. Piette (Rapport présenté par M. Ed. Sauvage au nom du Comité des Arts mécaniques, sur les appareils jaugeurs de M. Piette) Ed. Sauvage. Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 133, no. 4, April 1921, pp. 321–324, 5 figs. Differential manometers giving indications by magnetism.

MARINE BOILERS

Construction. Marine Boiler Construction. Machy. (Lond.), vol. 18, no. 453, June 2, 1921, pp. 265–271, 13 figs. Methods and machines employed in modern practice.

Design. Standard Conditions for the Design and Construction of Marine Boilers. Steamship, vol. 32, no. 384, June 1921, pp. 296–299. Conditions as to design, workmanship, hydraulic test, etc., Regulations of British Board of Trade. (Concluded.)

Oil-Burning. Oil-Fuel and Mixed-Fuel Burning in Marine Boilers. Shipbuilding & Shipping Rec., vol. 17, no. 23, June 9, 1921, pp 707–708. Methods of burning oil fuel. Practice in British navy. (To be continued.)

Safety Valves. Marine-Boiler Safety Valves, John G. Hub. Mech. World, vol. 69, no. 1795, May 27, 1921, pp. 408, 1 fig. Graphs for determining size of safety valves. Constructed by rule adopted by British Board of Trade, Lloyd's, British Corporation and Bureau Veritas.

Scotch. Quantity Production of Scotch Marine Boilers. Mar. Eng., vol. 26, no. 6, June 1921, pp. 442–445, 4 figs. Practice at works of Federal Shipbuilding Co., Kearny, N. J.

MARINE STEAM TURBINES

Assembling Methods. Turbine Work at the Puget Sound Navy Yard. Am Mach., vol. 54, no. 24, June 16, 1921, pp. 1044–1045, 7 figs. Methods of boring, blading and assembling ship turbines.

METALS

Fatigue. Investigation of Fatigue of Metals Under Stress, H. F. Moore. Min. & Metallurgy, no. 174, June 1921, p. 47. Damage from localized overstresses suggested as explanation of fatigue. (Abstract.)

Hardening. The Slip Interference Theory of the Hardening of Metals, Zay Jeffries and R. S. Archer. Chem. & Metallurgical Eng., vol. 24, no. 24, June 15, 1921, pp. 1057–1067, 11 figs. Mechanical conception of hardening of pure metals, allotropic and non-allotropic, of solid solutions of constant or variable solubility, and of metallic aggregates. In general, hardness is due to interference with slip characteristic property of ductile crystals.

Testing. Report of Committee E-1 on Methods of Testing. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 8 pp. Developments of standard methods of testing metals, especially iron and steel.

Viscosity. The Effect of Temperature on the Modulus of Rigidity and the Viscosity of Solid Metals, Kei Iokibé and Sukéaki Sakai. Tohoku Imperial University, Science Reports, vol. 10, no. 1, Mar. 1921, pp. 1–27, 17 figs. Experiments showed that internal viscosity of different metals increases with rise of temperature except in case of some metals and ferromagnetic substances. Internal viscosity of wire is greatly reduced by annealing.

METEOROLOGY

Aviation Service. Meteorology in the Service of Aviation, G. Dobson. Aeronautical Jl., vol. 25, no. 125, May 1921, pp. 223–229 and (discussion), pp. 230–236. States that meteorology should be of service in two main ways, namely by providing necessary information regarding all weather conditions likely to be encountered on any journey; and by providing statistical information required to settle certain definite questions and explaining physical causes of various phenomena.

METRIC SYSTEM

Arguments Against Adoption in U. S. Danger of Compulsory Metric Standards, H. S. Demarest. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 949–950. Report of Standardization Committee of Am. Supply & Mach. Manufacturers Assn. at Atlantic City, May 17. (Abstract.)

Arguments for Adoption in U. S. Report of Metric System Committee. Jl. Indus. & Eng. Chemistry, vol. 13, no. 5, May 1921, pp. 401–402. Committee report submitted to Am. Chem. Soc. More extensive and eventually exclusive use of metric system by chemists of U. S. is recommended.

British Decimal System vs. British Trade and the Metric System, E. A. W. Phillips. Concrete Inst. Trans., vol. 9, Apr. 1921, pp. 1–15 and (addenda and discussion) pp. F2–F18. Writer discusses possibility of making the British decimal system (explained in paper) the international standard for trade, commerce and engineering.

Great Britain. The Metric System and World Trade. Nature (Lond.), vol. 107, no. 2692, June 2, 1921, pp. 417–419. Argument in favor of legal adoption of Metric system in Great Britain.

MILLING MACHINES

Cam Milling. The Garvin 12-in Cam Milling Machine. A Suggested Improvement, J. Blakey and Jas. A. H. Shankley. Eng. & Indus. Management, vol. 5, no. 20, May 19, 1921, pp. 566–568, 5 figs. Improvement by employing tumbler gear device which permits milling double-sided cam.

MOLYBDENUM

Norway. Molybdenum Mines in Norway, Eugene Otto Falkenberg. Eng. & Min. Jl., vol. 111, no. 25, June 18, 1921, pp. 1021–1023. Molybdenite deposits occur in considerable quantities in a number of localities, specially in southern part. Mineral is geologically similar to that found elsewhere in the world. Translated from Teknisk Ukeblad.

Properties. Molybdenum, Arthur H. Hunter. Am. Iron & Steel Inst., advance paper, May 27, 1921, 20 pp. Occurences, manufacture, properties and uses.

MOLYBDENUM STEEL

Properties. Manufacture and Properties of Molybdenum Steels, Arthur H Hunter. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1469 & 1511–1512. Their adaptability to fabrication and their cost. Comparison with other alloy steels. Paper read before Am. Iron & Steel. Inst.

Uses. Molybdenum Steel and Its Application. M. H. Schmid. Trans. Am. Soc. for Steel Treating, vol. 1, no. 9, June 1921, pp. 500–505. Also in Chem. & Metallurgical Eng., vol. 24, no. 21, May 25, 1921, pp. 927–929. Beneficial effect of little molybdenum on physical properties of complex alloys, especially allowing safe use of high working temperatures and wide range of quenching and annealing heats. Uses in automotive forgings and pressed metal parts.

Molybdenum Structural Steels and Their Application, Martin H. Schmid. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1444–1445. Open-hearth practice. Blooming and finish rolling characteristics. Features in thermal manipulations. Paper read before Am. Soc. for Steel Treating.

MOTORSHIPS

Welded. An Electrically Welded Motor Ship. Ship-

building & Shipping Rec., vol. 17, no. 10, May 12, 1921, pp. 581–583, 4 figs. Dimensions: Length, 52 ft. 6 in.; breadth, molded, 13 ft. 1½ in.; depth, molded 6 ft. 10½ in.

N

NICKEL

Black. Black Nickel Solutions, Joseph Haas, Jr. Metal Industry (Lond.), vol. 18, no. 6, Feb. 11, 1921, pp. 106–107. Description of experiments performed, and results obtained in depositing black nickel without use of copper, arsenic or sulpho-cyanate salts.

Electrolytic. Ductile Electrolytic Nickel, Charles P. Madsen. Chem. & Metallurgical Eng., vol. 24, no. 21, May 25, 1921, pp. 922–924. Outline of experimental work on the electrolytes, cathodes and anodes leading to production of electrolytic nickel of greatly improved mechanical properties.

Properties. Nickel. U. S. Dept. of Commerce, Circular of Bur. of Standards, no. 100, Mar. 21, 1921, 106 pp., 26 figs. Properties, statistics of production, and metallurgy.

NICKEL PLATING

Solutions. The Use of Fluorides in Solutions for Nickel Deposition William Blum. Brass World, vol. 17, no. 5, May 1921, pp. 121–127, 3 figs. Notes on experiments upon the operation of solutions carried out at Bur. of Standards.

NON-FERROUS METALS

A.S.T.M. Committee Report. Report of Committee B-2 on Non-Ferrous Metals and Alloys. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 14 pp. Proposed tentative specifications, methods for chemical analysis, nomenclature and methods of testing.

O

OIL ENGINES

Bolnes. The Bolnes Marine Oil Engine, Arthur R. Brown. Practical Engr., vol. 63, no. 1788, June 2, 1921, pp. 340–341, 1 fig. Two-cycle engines of hot-bulb type.

Kromhout. Kromhout Motor for the Auxiliary Sailing Ship "Neppo." Engineering, vol. 111, no. 2891, May 27, 1921, pp. 646–648, 9 figs. Two-cycle four-cylinder oil engine developing 180 b.hp. at 300 r.p.m.

Vickers-Petters. Two-Stroke Crude-Oil Engine with Electric Starter. Engineering, vol. 111, no. 2891, May 27, 1921, pp. 656–657, 6 figs. Single-cylinder vertical Vickers-Petters engines of hot-bulb type giving working load brake horsepower of 22½ at speed of 375 r.p.m.

OIL FIELDS

Argentina. The Petroliferous Region of Malargué (La region petrolifera de Malargüé), Guillermo Hileman. Ingenieria Internacional, vol. 5, no. 6, June 1921, pp. 348–350, 2 figs. Geological notes on Argentina oil field.

Bolivia. Petroleum in Bolivia, Arthur H. Redfield. Eng. & Min. Jl., vol. 111, no. 23, June 4, 1921, pp. 955. Developments in exploition of oil fields.

Canada. Mackenzie River Oil Fields, E. A. Haggen. Min. & Eng. Rec., vol. 26, nos. 9 & 10, May 1921, pp. 95–116, 10 figs. Geological and topographical notes. Suggestions to prospectors.

Prospects of Oil at Peace River, Edmund M. Spieker. Min. & Eng. Rec., vol. 26, nos. 9 & 10, May 1921, pp. 116–122. Geological description of foothills of Rocky Mountains in British Columbia.

The Mackenzie Oilfield of Northern Canada, T. O. Bosworth. Petroleum World, vol. 18, no. 249, June 1921, pp. 233–241. Possibility of exploitation. Paper read before Instn. Petroleum technologists.

The Possibilities of the Oil Resources of Canada, D. B. Dowling. Trans. Royal Can. Inst., vol. 13, part 1, no. 29, Feb. 1921, pp. 39–47, 2 figs. Geological study.

Morocco. Petroleum at Morocco (Le pétrole au Maroc), Ed. Legé. Génie Civil, vol. 78, no. 16, April 16, 1921, pp. 331–335, 12 figs. Notes on origin and conservation of petroliferous products in northern Morocco.

Oklahoma. The Relation of Mountain Folding to the Oil and Gas Fields of Southern Oklahoma, Raymond C. Moore. Bul. Am. Assn. of Petroleum Geologists, vol. 5, no. 1, Jan.-Feb. 1921, pp. 32–48, 4 figs.

Oregon. Oil Developments in Rogue River Valley, Oregon, A. E. Kellogg. Eng. & Min. Jl., vol. 111, no. 22, May 28, 1921, pp. 913–914.

Pacific Coast. The Petroleum Field of the Pacific Coast, Earle W. Gage. Oil Field Eng., vol. 23, no. 5, May 1921, pp. 2–6, 4 figs. Notes on production and transportation of oil.

Persian-Mesopotamian. The Persian-Mesopotamian Oilfield. Petroleum World, vol. 18, no. 249, June 1921, pp. 225–232, 6 figs. Geological notes.

South America. Petroleum Production in South America with Relation to Recent Petroleum Legislation, J. W. Thompson. U. S. Dept. of Interior, Reports of Investigations, Bur. of Mines, serial no. 2250, May 1921, 6 pp.

Tennessee. Oil Development and Prospects in Tennessee, L. C. Glenn. Bul. Am. Assn. Petroleum Geologists, vol. 5, no. 2, Mar.-April 1921, pp. 168–172.

Texas. The Cretaceous of West Texas and Its Oil Possibilities. Charles Laurence Baker. Bul. Am. Assn. of Petroleum Geologists, vol. 5, no. 1, Jan.-Feb. 1921, pp. 5–28.

The West Columbia Oil Field, Brazoria County, Texas, Donald C. Barton. Bul. Am. Assn. Petroleum Geologists, vol. 5, no. 2, Mar.-April 1921, pp. 212–251, 13 figs.

United States. Our Future Oil Supply, David White. Eng. & Min. Jl., vol. 111, no. 23, June 4 1921, pp. 951–955. Early exhaustion of U .S. oil fields is considered inevitable.

West Virginia. Oil and Gas Development in West Virginia for the Year 1920, David B. Reger. Bul. Am. Assn. of Petroleum Geologists, vol. 5, no. 1, Jan.-Feb. 1921, pp. 80–84.

Wyoming. The Relative Ages of Major and Minor Folding and Oil Accumulation in Wyoming, Max W. Ball. Bul. Am. Assn. of Petroleum Geologists, vol. 5, no. 1, Jan.-Feb. 1921, pp. 49–63, 5 figs.

OIL SHALES

Bibliography. Oil Shale Industry—Selected Bibliography, Victor C. Alderson. Quarterly of Colorado School of Mines, vol. 16, no. 2, April 1921, pp. 27–38.

Distillation. Plant for Hot-Gas Pyrolytic Distillation of Shale, Louis Simpson. Petroleum Times, vol. 5, no. 122, May 7, 1921, pp. 521–523, 4 figs. Description and plan of a 2000-ton-per-day shale oil plant operating an indirect heating process employing hot gases for conveying reacting heat and resultant oil vapors from pyrolysis of the shale.

OIL WELLS

California. Regularity of Decline of Oil Wells in California, R. P. McLaughlin. Bul. Am. Assn. Petroleum Geologists, vol. 5, no. 2, Mar.-April 1921, pp. 178–185, 10 figs.

OPEN-HEARTH FURNACES

Egler. New Open Hearth Furnaces at Brier Hill, George L. Prentiss. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 368–370, 2 figs. Blair Eng. Co's installation under Egler patents. By this process flame is made blow torch rather than Bunsen burner.

Uses Blow Torch Idea in Furnace, George L. Prentiss. Iron Trade Rev., vol. 68, no. 23, June 9, 1921, pp. 1586–1587, 2 figs. Application of blow-torch principle to open-hearth furnaces. Egler patent.

McKune. The McKune System for Open Hearth, P. S. Young. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 371–374, 2 figs. Typical installations.

OXY-ACETYLENE WELDING

Boilers. Process for the Welding of Plants, Especially for Headers of Steam Boilers. (Verfahren zur Verschweissung von Blechen, insbesondere für Wasserkammern von Dampfkesseln). Autogene Metallbearbeitung, vol. 14, no. 8, Apr. 15, 1921, pp. 115–118, 2 figs. Method is developed based on experience and tests of writer.

P

PEAT

Recovery. The Recovery and Fuel Value of Irish Peat. U. S. Dept. of Commerce, Commerce Reports, no. 121, May 25, 1921, pp. 1150–1151. Report of British Dept. of Scientific & Indus. Research. Irish bogs are estimated to cover about 3,000,000 acres.

Utilization. The Use of Peat in Electrical Works (Torf-Elektrizitätswerke), P. Max Grempe. Elektrotechnische Rundschau, vol. 38, no. 6, Mar. 21, 1921, pp. 33–35, 2 figs. Large power plant in Wiesmoor, Germany, in which peat is burned. Details of equipment for production of peat, including excavators, peat-handling machines, and electrical equipment for drive of machines. Conveyance of the peat into power station. Results of experience and tests with burning of peat.

PETROLEUM

Nomenclature. British Petrographic Nomenclature. Min. Mag., vol. 24, no. 5, May 1921, pp. 278–281. Report of joint committee of Geological and Mineralogical Societies on standardization of petrological terms.

Products. Report of Committee D-2 on Petroleum Products and Lubricants. Am. Soc. for Testing Matls., paper of annual meeting June 21–24, 1921, 76 pp., 12 figs. Proposed tentative methods of testing for distillation of gasolene, naphtha, kerosene and similar products, for viscosity of fuel oils, for detection of sulphur and corrosive sulphur compounds in petroleum products in naphthas and illuminating oils, for open-cup flash and fire test and for cloud and pour points of petroleum products.

PIPE, CONCRETE

Hume. Making Concrete Pipes by Centrifugal Force. So. African Jl. of Industries, vol. 4, no. 3, Mar.-April 1921, pp. 224–235, 13 figs. Description of Hume process.

PIPE, STEEL

Centrifugal Casting. New Process for Automatic Making of Steel Tubing. Iron Age, vol. 107, no. 20, May 19, 1921, pp. 1300. Patented process for centrifugal casting of steel pipe. Process comprehends using electric melting of metal in conjunction with centrifugal casting and making of steel tubes, including those of alloy steels, such as are used for manufacturing ball-bearing races.

PIPING

Layouts. Steam Pipe Sizes, Alfred Cotton. Power, vol. 53, on. 21, May 24, 1921, pp. 832–836, 7 figs. Determination by pressure drop instead of velocity. Charts for 0 to 1,000,000 lb. of steam per hr. at pressures up to 300 lb. per sq. in.

PISTONS

Aluminum. Aluminum Piston Competition in Germany (Zum Aluminiumkolbenwettbewerb). Oel- u. Gasmaschine, vol. 18, no. 4, Apr. 1921, pp. 57–58. Interest centered especially in the light pistons of the Griesheim Chemical Works made of so-called electron metal, and in aluminum pistons made by Rudolph Rautenbach, Solingen. Technical notes on qualities of aluminum pistons.

PLANING

Production Systems. Production Planing in Machine Tool Plants. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 966–971, 6 figs. Practice at works of G. A. Gray Co. and of Cincinnati Planer Co.

Production Planing in Machine Tool Plants—. Machy. (Lond.), vol. 18, nos. 449 and 452, May 5 and 26, 1921, pp. 129–134, 11 figs. and 225–229, 4 figs. May 5: Practice of shops engaged in manufacture of drilling and boring machines and heavy lathes. May 26: Efficiency factors in production planing; points to observe in obtaining maximum output from planers.

PLATES

Deflection Under Load. The Equilibrium of Rectangular and Elliptic Plates under a Single Load (Ueber das Gleichgewicht von rechteckigen und elliptischen Platten unter einer Einzellast), Hans Happel. Eisenbau, vol. 12, no. 5–6, May 13, 1921, pp. 107–122. Calculations to determine deformation of plates under various conditions.

Stresses in. Researches on Thin Rectangular Plates (Recherches sur les plaques rectangulaires minces), M. Pigeaud. Annales des Ponts et Chaussées, vol. 60, no. 1, Jan.-Feb. 1921, pp. 5–47, 10 figs. Formulas for determining stresses.

PNEUMATIC TOOLS

Electric. Electrically Driven Riveting and Chisel Hammers (Elektrisch betriebener Niet- und Meissel Hammer). Der praktische Maschinen-Konstrukteur, vol. 54, no. 19, May 12, 1921, pp. 78–80, 8 figs. Arrangement consisting of small portable air pump and percussion type tool holder connected by a hose.

Heat Treatment. Heat-Treatment of Thor Toos Parts, J. V. Hunter. Am. Mach., vol. 54, no. 231 June 9, 1921, pp. 991–996, 20 figs. Efficient method, of heat-treating pneumatic tool parts. Contro system to check workmen.

POWER GENERATION

Industries. Industrial Power Loads, D. B. Rushmore and R. F. Emerson. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 475–478, 8 figs. Power demands of manufacturing industries in U. S. and factors which will govern supply of power in future.

PRESSES

Double-Action Drawing. Double-Action Drawing Press. Machy. (Lond.), vol. 18, no. 451, May 19, 1921, pp. 202–203, 2figs. Press designed by Arnold & Large, Ltd., Wolverhampton, in which a compensating action is incorporated, whereby any variation in thickness of plates above or below that for which machine is set is automatically provided for.

PRESSURE VESSELS

Stresses. Calculating Stresses in Pressure Vessels, William C. Strott. Boiler Maker, vol. 21, no. 6, June 1921, pp. 163–166, 4 figs. Strength of materials used in cylindrical tank construction and allowable external pressures on vacuum tanks. (Concluded.)

PROFIT SHARING

British Works. Profit Sharing in Practice. Eng. & Indus. Management, vol. 5, no. 18, May 5, 1921, pp. 513–514. Scheme of profit sharing adopted at works of W. G. Armstrong, Whitworth & Co., Ltd., Rules of employees' deposit fund in operation at these works.

PROPELLERS, SHIP

Standardization. Propeller Wheel Mold Standardization, Enrique Touceda. Foundry, vol. 49, no. 11, June 1, 1921, pp. 431–435, 7 figs. By employing accurately fitting flasks and rigging, propeller wheels true to size and pitch are turned out in about one tenth of usual time. Molding method of George H. Thatcher & Co., Albany, N. Y. Paper read before Am. Inst. Min. & Metallurgical Engrs.

PROTECTIVE COATINGS

Tests. The Protection of Iron with Paint Against Atmospheric Corrosion, J. Newton Friend. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 5, pp. 4. Experiments on value of several protective coatings.

PULVERIZED COAL

Combustion. Effect of Preheat and Excess Air on Combustion of Fuel, A. D. Williams. Power, vol. 53, no. 24, June 14, 1921, pp. 960–962, 3 figs. Graphs showing characteristic combustion of pulverized coal.

Developments. Use of Powdered Fuel Under Steam Boilers, Harlow D. Savage. Am. Iron & Steel Inst., advance paper, May 27, 1921, 41 pp., 18 figs. Also in Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1464–1467, 2 figs. Survey of developments in installation of equipment for burning pulverized coal in steam-power plants. Tests and comparative costs. Paper read before Am. Iron & Steel Inst.

Industrial Heating. Industrial Heating with Pul-

verized Coal (Le chauffage au charbon pulvérisé). Revue générale del' Électricité, vol. 9, no. 22, May 28, 1921, pp. 768–771. Third report of Committee on Economical Utilization of Fuel appointed by French Minister of Public Works. Report deals with survey of developments and requirements for burning pulverized coal efficiently. (To be continued.)

Tests. Present Status of Powdered Coal, Chas. Longenecker. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 394–397, 1 fig. Tests illustrating results obtained in burning various grades of coal.

Uses. Note on the uses of Pulverized Coal (Quelques considerations sur l'emploi du charbon pulvérisé), M. Bulle. Chaleur et Industrie, vol. 2, no. 4, April 1921, pp. 184–188, 2 figs. Design of furnaces for burning pulverized coal.

PUMPING

Costs. Record System of Steam and Motor Pumping Costs, O. A. Anderson. Power, vol. 53, no. 22, May 31, 1921, pp. 887–892. Tables showing quantities of water required for condensers of steam and refrigerating systems and amount of air per gallon of water in air-lift system.

PUMPS

Rotary. A New Principle of Rotary Pump Construction, S. H. Farkas. Chem. & Metallurgical Eng., vol. 24, no. 23, June 8, 1921, pp. 1025–1026. Description of Exeter rotary pump.

PUMPS, CENTRIFUGAL

Efficiency. Centrifugal Pumps—II. Dependency of Efficiency upon Type, Size and Speed, W. D. Canan. Power, vol. 53, no. 20, May 17, 1921, pp. 780–782, 3 figs. Methods of plotting curves.

Operation. Baltimore Pump Sets New Duty Record for Centrifugals. Eng. News-Rec., vol. 86, no. 22, June 2, 1921, pp. 938–939, 3 figs. Tests showed maximum duty of 1,720,250,000 ft-lb. per 1000 lb. of steam at 175 lb. gage pressure, 60 deg. fahr. superheat and water temperature of 70 deg. fahr.

Wilfley. The Wilfley Centrifugal Pump, John Goodman. Practical Engr., vol. 63, no. 1786, May 19, 1921, pp. 311–313, 4 figs. Extracts from report on series of tests carried out on new type of centrifugal pump produced by Wilfley Co., Ltd., London, having impeller fitted with hollow trunnion through which suction water passes on its way to impeller passages.

R

RADIOMETALLOGRAPHY

Research. Roentgen Spectrographic Investigations of Iron and Steel, Arne Westgren. Iron & Steel Inst., annual meeting, May 5–6, 1921 paper no. 11, 23 pp., 4 figs. Research at Physical Instn. of University of Lund, Sweden. Investigations have shown that atoms of iron at ordinary temperature and at 800 to 830 deg. cent. are oriented in exactly the same way, a conclusion which is held to prove that iron does not undergo any allotropic transformation at 768 deg. cent.

RAILS

Acid Bessemer. Bessemer Acid Steel Rails, Cecil J. Allen. Ry. Engr., vol. 42, no. 496, May 1921, pp. 182–184. Records of tests.

Failures. Punishment of Rails, James E. Howard. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1375–1376, 3 figs. Report to Interstate Commerce Commission on failure of 75-ton Bessemer steel rail. Attention is drawn to difference, both in original and in effect, of rail hardness produced by cold-rolling action of wheels and by their slipping.

Rerolling. Rerolling Rails in New Ohio Mill, John D. Knox. Iron Trade Rev., vol. 68, no. 20, May 19, 1921, pp. 1384–1387, 6 figs. Rerolling mill containing seven stands of 14-in. rolls.

RAILWAY ELECTRIFICATION

India. The Electrification of Indian Railways. Ry. Engr., vol. 42, nos. 496 and 497, May and June 1921, pp. 185–188, and 1 fig., and 218–222, 14 figs. Advantage of using electric locomotives as compared with steam locomotives in heavily graded sections of North Western Ry. of India.

Switzerland. Electrification of St. Gotthard Line, Switzerland, Hans W. Schuler. Ry. Elec. Engr., vol. 12, no. 6, June 1921, pp. 221–227, 15 figs. Electrified section is 101 miles long and has average grade of 2.6 per cent for 30 miles. Single-phase, 15,000-volt power is used.

The Electrification of the Swiss Railways. Engr., vol. 131, no. 3413, May 27, 1921, pp. 563–564. Survey of developments.

RAILWAY MOTOR CARS

Gasoline-Driven. Gasoline-Driven Motor Omnibus for Railroads. Ry. Age, vol. 70, no. 23, June 10, 1921, pp. 1363–1364, 2 figs. Two car units consisting of motor car and trailer for passenger service on branch lines.

RAILWAY OPERATION

Material vs. Personnel Expenses. How Material Costs Affect Railway Income, Harrington Emerson. Ry. Rev., vol. 68, no. 23, June 4, 1921, pp. 851–854, 2 figs. Material vs. personnel expenses considered upon basis of the equated locomotive day.

Selection and Training of Personnel. The Selection and Training of Personnel for Railroad Service (Auslese und Ausbildung des Personals für den unteren Betriebsdienst), Hans Busse. Archiv für Eisenbahnwesen, no. 3, May-June 1921, pp. 564–581, 2 figs. Recommends following measures for increasing efficiency of operation: Selection and correct classification of employees with aid of psychotechnical adaptability test; improvement in instruction methods; regulation of working conditions according to efficiency; suitable arrangement of working and rest quarters; wide use of technical expedients for facilitating work.

Train Dispatching. New Record Demonstration of Heavy Tonnage Train Handling. Ry. & Locomotive Eng., vol. 34, no. 6, June 1921, pp. 151–155, 7 figs. Experience of Virginian railway in handling trains of 16,000 gross tons on heavy grades in regular train service.

Train Loading. Record Train Loading Features Virginian Operation. Ry. Age, vol. 70, no. 21, May 27, 1921, pp. 1203–1208, 7 figs. Methods used to handle loads of 8000 to 9000 tons in regular course.

RAILWAY REPAIR SHOPS

Welding. Shop Notes from Buffalo. Elec. Ry. Jl., vol. 57, no. 25, June 18, 1921, pp. 1114–1118, 14 figs. Reclamation of material and welding methods at railway repair shop of Int. Ry., Buffalo.

RAILWAY SHOPS

Mechanical Equipment. Revivifying the Railroad Shop, G. W. Armstrong. Ry. Mech. Engr., vol. 95, no. 6, June 1921, pp. 341–345, 8 figs. Notes on installation of mechanical equipment.

RAILWAY SIGNALING

England. Three-Position Signaling in Great Britain Ry. Signal Engr., vol. 14, no. 6, June 1921, pp. 211–216, 10 figs. First installation of this type in England made on Great Western. A. C. apparatus fog repeators and automatic stops used.

RAILWAYS

Narrow-Gage. Development of Narrow-Gage Railways in Prussia (Entwicklung der Kleinbahnen in Preussen). Archiv für Eisenbahnwesen, no. 3, May-June 1921, pp. 607–637. Statistical data.

Short Line Roads. The Transportation Problem and the Short Line Roads. Ry. Rev., vol. 68, no. 23, June 4, 1921, pp. 860–862. Extracts from report of president of American Short Line Railroad Assn.

REAMERS

Manufacture. Solid Reamers for Precision Holes (Feste Reibahlen fur Genaulöcher), Jos. Reindl. Betrieb, vol. 3, no. 16, May 10, 1921, pp. 461–467, 21 figs. As excess of reamer diameter for limit-gage holes, $\frac{2}{5}$ to $\frac{3}{4}$ of the tolerance above lower measurement of hole is accepted as permissible. Writer recommends that hand reamers be tapered at end for a length equal to $\frac{1}{4}$ the length of flute. Notes on grinding of hand and machine reamers.

Standards. Report of the German Industries Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 16, May 10, 1921, pp. 227–239, 19 figs. Proposals of Board of Directors for hand and machine reamers (solid adjustable and shell), and pilot shanks.

REDUCTION GEARS

Design. Mechanical Reduction Gears on Warships and Merchant Ships, John H. Macalpine. Engineering, vol. 111, nos. 2890 and 2891, May 20 and 27, 1921, pp. 609–611, and 640–642, 2 figs. Graphs indicating tooth pressure per inch of face. Arguments against introducing flywheel just aft of gear.

REFRACTORIES

Oil-Fired Furnaces. Refractories for Oil-Fired Furnaces and Boilers, W. H. Grant. Jl. Am. Ceramic Soc., vol. 4, no. 5, May 1921, pp. 390–392. Causes of failure of firebrick in oil-fired furnaces.

Tests. Resistance Tests on Refractory Products under Load at Different Temperatures, V. Bodin. Colliery Guardian, vol. 121, no. 3151, May 20, 1921, pp. 1454–1455, 3 figs. Account of experiments and table showing resistance figures for various substances tested. (Abstract.) Paper read before Ceramic Soc., Refractory Materials Sect., Paris. See also Iron & Steel Trades Rev., vol. 102, no. 2777, May 20, 1921, pp. 694–695, 1 fig.

REFRIGERATING PLANTS

Steam Engines. Steam Engines for Refrigerating Plants, W. H. Motz. Power, vol. 53, no. 23, June 7, 1921, pp. 916–919, 6 figs. Selection and efficient operation of steam engines for driving ice-making and refrigeration plants. Graphs showing comparative performances of various steam engines.

Wall Insulation. Insulation of Concrete Walls Nolan D. Mitchell. Concrete Age, vol. 34, no. 2, May 1921, pp. 15–17. Tables giving heat conductivity of common wall materials.

Welded Ammonia Containers. Some Tests on Welded Ammonia Containers, E. A. Fessenden. A.S.R.E. Jl., vol. 7, no. 4, Jan. 1921, pp. 281–305, 31 figs. Results of tests made to compare different methods of constructing cylinders for handling anhydrous ammonia in refrigerating plant practice.

RESEARCH

British Association. The British Research Association for the Woolen and Worsted Industries, James P. Hinchliffe. Jl. Royal Soc. of Arts, vol. 69, no. 3575, May 27, 1921, pp. 439–453. Constitution and activities.

Industrial. Governmental Research, George K. Burgess. Trans. Royal Can. Instn., vol. 13, part 1, no. 29, Feb. 1921, pp. 121–132. Discusses organization of industrial research under auspices of government.

Scientific, United States. Funds Available in 1920 in the United States of America for the Encouragement of Scientific Research, Callie Hull. Bul. Nat. Research Council, vol. 2, no. 9, part 1, Mar. 1921, 81 pp.

University of Illinois. The Functions of the Engineering Experiment Station of the University of Illinois, Charles Russ Richards. University of Ill. Bul., vol. 18, no. 24, Feb. 14, 1921, 21 pp.

ROAD CONSTRUCTION

Machinery. Road Building and the Mechanical Engineer, B. H. Piepmeier, R. C. Marshall, Jr. and C. D. Curtis. Mech. Engr., vol. 43, no. 6, June 1921, pp. 386–390, 5 figs. Problems in relation to road-building machinery presented under auspices of Materials Handling Division at Am. Soc. Mech. Engrs. spring meeting. Titles of papers were: Road-Construction Plants; Mechanical Needs in Highway-Construction Machinery; and Planning and Organizing a Road Job for Mechanical Handling of Material.

ROADS, CONCRETE

Reinforced. New Design for Illinois Concrete Highways. Eng. World, vol. 18, no. 6, June 1921, pp. 421–422, 3 figs. Corrugated longitudinal center joint. Bars tie adjacent sections and resist shear.

ROCK DRILLS

Magnetic Analysis. Application of Magnetic Analysis to Rock Drills, Charles W. Burrows. Min. & Metallurgy, no. 174, June 1921, pp. 42–43, 1 fig. Experience in use of magnetic defectoscope. (Abstract.)

Steel. What is the Ideal Drill Steel? Frank H. Kingdon. Min. & Metallurgy, no. 174, June 1921, pp. 47 and 50–51, 1 fig. Answers to questionnaire showed that double-arc, double-taper bit and cross-bit give best service.

Tests. Analysis of Some Drill-Steel Tests, Francis B. Foley. Min. & Metallurgy, no. 174, June 1921, pp. 43 and 46–47, 1 fig. Tests on breakage of shank and bit end. Breakage is attributed to faulty practice in forging and hardening. (Abstract.)

ROLLING MILLS

Cost of Rolling Steel. Review of Cost of Rolling Steel in Various Mills, G. E. Stoltz. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 5, May 1921, pp. 99–115 and (discussion) pp. 116–154, 2 figs. 1 on supp. plate. Outlines method of reducing cost of producing steel. Includes tables of power and main drive operating cost of rolling steel, and chart showing comparison of cost of rolling steel on electric and steam-driven reversing blooming mills.

Sheet Mills. Operates Sheet Mill in Indiana, E. F. Ross. Iron Trade Rev., vol. 68, no. 24, June 16, 1921, pp. 1651–1656, 8 figs. Mill galvanizing plant and fabricating shop designed with a view to simplifying handling of materials.

ROPE DRIVE

Belting vs. Manila Rope and the Engineer, Rupert E. Shotts and Harry E. Wade. Eng. World, vol. 18, no. 6, June 1921, pp. 405–409, 4 figs. Graph giving relative cost per foot of drive for rope and belting, using most efficient speeds in each case.

Wire Rope. Power Transmission by Wire Rope, L. J. Dixon. Power, vol. 53, no. 22, May 31, 1921, pp. 893–896, 8 figs. Application and arrangement of system, type and size of sheaves. Rope construction, driving tension, velocities and horsepower transmitted. Idle sheaves and takeup devices.

S

SCALES

Track. 200-Ton Railway Track Scale, Canadian Pacific Railway, H. S. Bare. Can. Ry. & Mar. World, no. 279, June 1921, pp. 289–290, 7 figs. Tapered floor deck is notable feature.

SCIENTIFIC INSTRUMENTS

Design. The Design and Construction of Scientific Instruments, Robert S. Whipple. Engineering, vol. 111, no. 2891, May 27, 1921, pp. 659–662, 12 figs. Presidential address at meeting of British Optical Soc.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW THREADS

Standardization. Committee for Standardization of Screw Threads (Commission pour l'unification des filetages). Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 133, no. 4, April 1921, pp. 380–383, 1 fig. Table giving standard dimensions of bolts and screws of from 2.5 mm. to 12 mm. diameter. Adopted by Committee of Union of Electrical Syndicates in France.

SEMI-DIESEL ENGINES

Vegetable Oils as Fuel. Vegetable Oils as Fuel for Semi-Diesel Engines, Eugenio Normand. Shipbuilding & Shipping Rec., vol. 17, no. 21, May 26, 1921, pp. 649–650, 2 figs. Experiments carried out by Ansaldo San Giorgio Works on 20 b.hp. semi-Diesel engines.

SHAFTS

Keyways. Influence of Circular Holes and Keyways on the Strength of Shafts (Einfluss von Löchern und Nuten auf die Beanspruchung von Wellen), L. Föppl. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 19, May 7, 1921, pp. 497–498, 2 figs. Increase

of stress in shafts due to perforations is said to be the same as in a similarly perforated plate. Increase in danger of rupture due to holes and keyways is twice and three times as great.

SHIP PROPULSION

Hernu Propulsion Turbine. Mechanical Propulsion of Ships (Les bateaux a propulsion mécanique), M. Monfier. Nature (Paris), no. 2458, May 14, 1921, pp. 308-310, 2 figs. Description of Hernu propulsion turbine.

Jet Propulsion. The Effective Propulsion of Craft for use on Shallow and Obstructed Waterways, J. H. Gill. Trans. Inst. Mar. Engrs., session 1921-22, vol. 33, Apr. 1921, pp. 57-74, 14 figs. Discussion of jet propulsion.

SHIP PROPULSION, ELECTRIC

U. S. S. Tennessee. Electric Drive and the U. S. S. Tennessee, H. M. Southgate. Elec. Jl., vol. 18, no. 6, June 1921, pp. 239-289, 70 figs. Series of articles describing propelling machinery of U. S. S. Tennessee. Titles are: Motion—$30,000,000 Worth R. A. Bachmann; General Arrangement of Propelling Machinery for the U. S. S. Tennessee, W. E. Thau; The Propelling Motors of the U. S. S. Tennessee, H. L. Barnholdt; The Control Room Circuit Breaker Equipment of the U. S. S. Tennessee, E. K. Read; The Control Equipment for the Propelling Machinery of the U. S. S. Tennessee, M. Cornelius; The Lighting Sets on the U. S. S. Tennessee, J. A. MacMurchy and A. O. Loomis; The Condensing Equipment and Oil Cooling System for the U. S. S. Tennessee, J. H. Smith and A. O. Loomis; The Control of the Secondaries of the Main Propulsion Motors of the U. S. S. Tennessee, W. C. Goodwin; The Stability Indicator, R. T. Pierce; The Main Turbines and Turbine Speed Control for the U. S. S. Tennessee, W. B. Flanders; The Main Generators of the U. S. S. Tennessee, R. E. Gilman and Installation and Maintenance of Automatic Substations, C. A. Butcher.

SOOT BLOWERS

Tests. Some Results with Mechanical Soot Blowers, Robert June. Power House, vol. 14, no. 7, April 5, 1921, pp. 21-24. Survey of recent tests with coal, pulverized fuel and oil.

SPRINGS

Formulas for Design. Formulas for Spring Design. Machy. (Lond.), vol. 18, no. 451, May 16, 1921, pp. 209-211, 4 figs. Formulas used by draftsmen and designers of Briggs Stratton Co., Milwaukee.

SPROCKET CHAINS

Standardization. Proposed Standard Roller-Chain Sprocket. Am. Mach., vol. 54, no. 24, June 16, 1921, pp. 1052-1053, 2 figs. Excerpt from report of Chain Division of Standards Committee of Soc. of automotive Engrs. at West Baden, Ind., May 24, 1921.

SPRUCE

Moduli of Rigidity. The Moduli of Rigidity for Spruce, H. Carrington. Lond., Edinburgh & Dunlin Philosophical Mag. & Jl. of Sci., vol. 41, no. 246, June 1921, pp. 848-860, 6 figs. partly on supp. plate. Investigations conducted in College of Technology, Manchester, for British Air Board and Royal Aircraft Establishment.

STACKS

Corrosion. Surrounding Corroded Steel Stacks with Concrete, John V. Schaefer. Power Plant Eng., vol. 25, no. 11, June 1, 1921, pp. 560-561, 2 figs. Experience at South Works, Illinois Steel Co., South Chicago.

STAMPING

Methods. Producing a Stamped Shift Lever Dome, N. T. Thurston. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1441-1444, 11 figs. Dies and method of production.

STANDARDIZATION

Australia. An Engineering Standards Association for Australia. Sci. & Industry, vol. 2, no. 1, Jan. 1921, pp. 43-44. Scheme of organization for Australian Standards Association. Proposal has been approved by committee appointed by Council of Instn. of Engrs., Australia.

STEAM

Entropy. Entropy of Steam, M. J. Eichhorn. Power vol. 53, no. 24, June 14, 1921, pp. 966-967, 1 fig. Nomogram for entropy of steam.

High-Pressure. The Properties of High-Pressure Steam, M. J. Eichhorn. Power, vol. 53, no. 20, May 17, 1921, pp. 782-783, 1 fig. Nomogram for properties of steam up to critical point.

Properties. Properties of Steam (Ueber einige Eigenschaften des Wasserdampfes), Max Jacob Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 22, May 28, 1921, pp. 568-570. Criticisms of German technical—thermodynamical research made by English journal, Engineering, are refuted. In particular, it is shown that the well-known and established equations of state of steam, including the simple equation of Callendar, in the neighborhood of saturation at high pressures, lead to values of specific heat which are contradictory to the experimental results. On the other hand, the specific volume can be obtained from the experimental values of the specific heat, graphically or as shown by Eichelberg, in form of a broadly applicable equation of state.

Superheated. See SUPERHEATED STEAM.

Total Heat. Total Heat of Steam, M. J. Eichhorn. Power, vol. 53, no. 23, June 7, 1921, pp. 936-937, 1 fig. Nomogram for total heat of steam, computed from heat formulas.

STEAM ENGINES

High-Power. High-Power Engines and Heat Utilization (Grosskraftmaschinentechnik und Wärmeausnutzung), H. Schömburg. Wirtschaftsmotor, no. 3, Mar. 1921, pp. 17-19, 9 figs. Describes several such machines which are among the largest of their kind, including two blast-furnace blowing engines by Ehrhardt & Sehmer, Saarbrücken; the largest steam engine built by same firm and various types of turbocompressors.

Uniflow. Uniflow Steam Engines with High-Lift Conoidal Disk Valve and Layshaft of Double Speed (Gleichstromdampfmaschine mit Hochhub-Düsentellerventil und Steuerwelle doppelter Drehzahl), J. Stumpf. Zeit des Vereines deutscher Ingenieure, vol. 65, no. 19, May 7, 1921, pp. 492-494, 7 figs. Discusses diminishing the clearances and surfaces of uniflow engines by employing high-lift conoidal disk inlet valves driven by layshaft whose speed is double that of engine. Abstracted from author's book, "Die Gleichstromdampfmaschine," R. Oldenbourg, Münich.

[See also REFRIGERATING PLANTS. Steam Engines.]

STEAM-ELECTRIC PLANTS

Chemical Works. New Power Plant of Monsanto Chemical Works. Power, vol. 53, no. 20, May 17, 1921, pp. 768-773, 7 figs. Power plant in which compound steam engines generate direct current for electrolytic work and discharge their exhaust to mixed-pressure turbo-generators which furnish alternating current for lighting and power.

Chicago Calumet Station. Calumet Station Equipment and Operating Features. Elec. Rev. (Chicago), vol. 78, no. 22, May 28, 1921, pp. 849-851 and 870-871, 3 figs. Details of coal-handling and burning apparatus, generating units, and switching equipment.

Developments. Practices and Tendencies in Steam Generating Plants. Elec. World, vol. 77, no. 23, June 4, 1921, pp. 1311-1314, 4 figs. Tendency is to increase turbine speeds and to improve turbine economy by raising steam pressure. Committee report submitted at conference of Nat. Elec. Light Assn.

Dodge Bros. Dodge Brothers' New Power Plant.* Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1391-1394, 6 figs. Steam-electric plant built on unit plan, each unit consisting of two boilers and with generating capacity of 10,000 kw.

Dodge Brothers Modern Power Plant, Thomas Wilson. Power, vol. 53, no. 21, May 24, 1921, pp. 841-849, 14 figs. Plant is arranged on unit plan and is to have ultimate capacity of 50,000 kva. Combined natural—and induced-draft cooling tower is mounted 33 ft. above grade over loading platform. To maintain heat balance house turbine is to operate in conjection with synchronous-motor-generator set.

Glasgow. The Dalmarnock Power Station. Engineering, vol. 111, nos. 2891 and 2893, May 27 and June 10, 1921, pp. 635-639 and 650, 38 figs. partly on 4 supp. plates, and 703-707, 21 figs. Glasgow steam-electric plant designed for ultimate capacity of 200,000 kw. Details of 16,000-kw. three-phase generators.

Heat Balance. Heat-Balance Study of Colfax Power Station, W. P. Gavit. Power, vol. 53, no. 21, May 24, 1921, pp. 824-827, 4 figs. Thermal efficiency of Colfax station is 18.46 as compared with 20.2 for ideal station.

Pennsylvania. The Generating Systems of the West Penn Power Company, G. G. Bell. Elec. Jl., vol. 18, no. 5, May 1921, pp. 175-193, 18 figs. Steam-electric plants with capacities of 60,000 kw., 30,000 kw., and 25,000 kw.

Philadelphia. Delaware Power Station—The Philadelphia Electric Company. Power, vol. 53, no. 21, May 24, 1921, pp. 806-817, 14 figs. Steam-electric plant designed for capacity of 180,000 kw. in six 30,000-kw. units, of which two have been installed. Single cylinder turbo-generating units operating at 1800 r. p. m. are used.

Pittsburgh. The Power Stations of the Duquesne Light Company, J. M. Graves. Elec. Jl., vol. 18, no. 5, May 1921, pp. 193-210, 20 figs. Colfax station in Pittsburgh district with present capacity of 60,000 kw.

Toledo. The Acme Power Company Plant, Cyril E. Lewis. Elec. Traction, vol. 17, no. 5, May 1921, pp. 301-305, 4 figs. Power plant at Toledo, Ohio, designed for ultimate capacity of 200,000 kw., including modern generating machinery and coal-handling facilities.

STEAM POWER PLANTS

Central Heating Stations. Modern Tendencies in the Construction of Central Plants (Les tendances modernes dans la construction des centrales), F. Scoumanne. Revue universelle des Mines, vol. 9, no. 3, May 1, 1921, pp. 229-241, 2 figs. Central heating stations. (To be continued.)

Operation. Efficient Operation of Oil Burning Steam Plants, C. H. Delany. Power Plant Eng., vol. 25, no. 11, June 1, 1921, pp. 551-556, 7 figs. Method of establishing standards of efficiency at various loads. Paper read before San Francisco Section, Am. Soc. Mech. Engrs.

Power for Toasting Cornflakes. Power Plant Eng., vol. 25, no. 11, June 1, 1921, pp. 545-550, 11 figs. Details of equipment and operation of steam power plant.

STEAM TURBINES

Developments. Recent Improvements in Steam Turbine Design. Engr., vol. 131, nos. 3410, 3412 and 3413, May 6, 20 and 27, 1921, pp. 482-484, 5 figs., 534-536, 10 figs., and 562-563, 6 figs. May 6: Marine-type geared turbo-generator manufactured by W. H. Allen, Sons & Co., Bedford, England. May 20: Types recently manufactured by Brown, Boveri & Co. May 27: Types built by English Electric Co.

Shaft Glands. Steam-Turbines Shaft Glands, John R. Baker. Power, vol. 53, no. 22, May 31, 1921, pp. 881-883, 6 figs. Methods of packing.

Thyssen-Röder Limit. The Thyssen-Röder Steam Turbineas a Limit Turbine, Karl Röder. Eng. Progress, vol. 2, no. 4, Apr. 1921, pp. 81-82, 3 figs. Reaction drum is fitted with disks without central bore, thus permitting control of volume of bore-pressure steam with small losses due to exhausting.

STEEL

A. S. T. M. Committee Report. Report of Committee A-1 on Steel. Am. Soc. for Testing Matls., paper of annual meeting, June 21-24, 1921, 42 pp., 1 fig. Proposed revisions in standards and tentative standards for steel, welded and seamless steel pipe, carbon steel, rails, cold-drawn steel wire for concrete reinforcement, and boiler tubes.

Alloy. See ALLOY STEELS.

Basic. Deoxidation Phenomena in the Basic Process (Desoxydationsvorgänge im Thomasverfahren), O. von Keil. Stahl u. Eisen, vol. 41, no. 18, May 5, 1921, pp. 605-611, 3 figs. Results of tests carried out in nine large basic steel works presented in tables and charts.

Drill. Drill Steel from Hollow Ingots, P. A. E. Armstrong. Chem. & Metallurgical Eng., vol. 24, no. 22, June 1, 1921, pp. 960-964, 9 figs. Definite effort to produce hollow drill steel with decarbonized interior surface by inserting mild-steel tube in ingot mold, plugging it with sand, casting steel and subsequently rolling to size. Paper read before Am. Min. & Metallurgical Engrs.

Impact Testing. Impact Testing of Notched Bars (Essais de choc sur barreaux entaillés), M. Legrand. Revue de Métallurgie, vol. 18, no. 4, April 1921, pp. 225-228, 1 fig. Tests conducted by French Permanent Commission. Bars tested were of Martin steel.

New Impact Tests Conducted by the French Standardization Commission (Quelques essais de choc sur nouvelles éprouvettes de la commission de standardisation), M. Léon Guillet. Revue de Métallurgie, vol. 18, no. 4, April 1921, pp. 221-224. Tests on steel bars subjected to different heat treatments.

Internal-Combustion Engine Valves. Steels for Internal-Combustion Motor Valve, G. Gabriel. Automotive Manufacturer, vol. 42, no. 2, May, 1921, pp. 19-22. Minimum requirements as determined in use of light-weight and airplane engines. Effect of high temperatures on various steel. Metallurgical viewpoints Translated from La Technique Automobile et Aerienne. (To be continued.)

Marine Engineering. Steel from the Standpoint of Marine Engineering, W. H. Hatfield. Jl. West of Scotland Iron & Steel Inst., vol. 28, part 5, session 1920-1921, Feb. 1921, pp. 52-72 and (discussion) pp. 72-78, 17 figs. on 2 supp. plates. Writer concludes that (1) it is desirable to use, wherever possible, ship plates and sections of increased mechanical strength; (2) it is advisable to extend use of some special steels now available for power unit and transmission parts; and (3) it is desirable to increase use of other special steels available for resisting rust and where needed, high temperatures.

Mechanical Properties. Calculation of Mechanical Properties of Steel from its Chemical Composition, Hugh O'Neill. Iron & Coal Trades Rev. vol. 102, no. 2777, May 20, 1921, pp. 700. Formula is developed.

Metallography. Report of Committee E-4 on Metallography. Am. Soc. for Testing Matls., paper of annual meeting, June 21-24, 1921, 16 pp. Proposed tentative methods of metallographic testing on iron and steel.

Molybdenum. See MOLYBDENUM STEEL.

Quenching Cracks. On the Cause of Quenching Cracks, Kôtarô Honda, Tokujirô Matsushita and Sakaé Idei. Iron & Steel Inst., annual meeting, May 5-6, 1921, advance paper no. 6, 16 pp., 9 figs. It is concluded from tests that in quenched steel certain amount of austenite is generally present intermingled in martensite. Amount of austenite increases as quenching temperature increases. Quenching cracks occur when hardness in central portion is much greater than in periphery.

Specifications. French Specifications for Carbon Steels. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1372-1374. Full details for bars, blooms, billets and slabs of other than tool steels. Static. structure and shock, as well as welding tests, required.

Stainless. Stainless Steel, Its Composition and Properties, Elwood Haynes. Iron Age, vol. 107, no. 22, 107, no. 22, June 2, 1921, pp. 1467-1469. Manufacture and uses. Influence of temperature. Limits of chromium content. Paper read before Am. Iron & Steel Inst.

Sulphur Determination. Comparison of Different Methods of Estimating Sulphur in Steel, T. E. Rooney. Iron & Steel Inst., annual meeting, May 5-6, 1921, advance paper no. 9, 13 pp. Experiments made with carbon and nickel-chromium steels.

Tests. Comparative Tests of Steels at High Temperatures, R. S. MacPherran. Am. Soc. for Testing Matls., paper of annual meeting, June 21-24 1921, 9 pp., 6 figs. Tests made to determine comparative properties of various steels at high temperatures under operating conditions at temperature between 600 to 1000 deg. fahr.

STEEL CASTINGS

Centrifugal. Testing Centrifugally Cast Steel, George K. Burgess. Iron Trade Rev., vol. 68, no. 21, May 26, 1921, pp. 1443-1447, 15 figs. Examination of several cylinders of various wall thickness and composition showed little segregation of elements and few blow holes. Physical properties of specimens were improved materially by heat treatment.

Manufacture. Checking Troubles in Steel Castings, R. B. Farquhar, Jr. Foundry, vol. 49, no. 12, June 15, 1921, pp. 475-483, 23 figs. Notes on proper pouring, gating and feeding. Paper read before Am. Foundrymen's Assn.

STEEL FOUNDRIES

Electric-Furnace. Steel Foundry Rearranged and Enlarged, Gilbert L. Lacher. Iron Age, vol. 107, no 22, June 2, 1921, pp. 1470-1474, 9 figs. Replacement of cupolas and converters by electric furnace at plant of Chicago Steel Foundry Co.

STEEL, HEAT TREATMENT OF

Drill Steel. Heat Treatment of Rock-Drill Steel, George H. Gilman. Min. & Metallurgy, no. 174, June 1921, pp. 35 and 38-39 and 42, 1 fig. Suggestions in regard to heat-treating practice. (Abstract.)

Methods. Carburizing, Hardening and Tempering High Carbon Alloy Steels in 130 Minutes, R. L. Gilman. Trans. Am. Soc. for Steel Treating, vol. 1, no. 8, May 1921, pp. 445-448. Method is suggested.

Tool Steel. The Prevention of Hardening Crack and the Effect of Controlling Recalescence in a Tungsten Tool Steel, Shipley N. Brayshaw. Iron & Steel Inst., annual meeting, May 5-6, 1921, advance paper no. 1, 86 pp., 26 figs. Research carried out on tool steel containing about 1.1 per cent of carbon and 0.8 to 0.9 per cent of tungsten. Changes that occur during halts in heating and cooling were investigated in number of bars which, after soaking for various periods of time at temperatures near critical points, were quenched in water. Results suggested that, both in heating and in cooling, changes Ac1. 2.3 and Ar 3.2.1. take place in stages which may be separated one from another if sufficient time is allowed for process.

STEEL, HIGH-SPEED

Hardness. Relation of the High Temperature Treatment of High Speed Steel to Secondary Hardening and Red Hardness, Howard Scott. Trans. Am. Soc. for Steel Treating, vol. 1, no. 9, June 1921, pp. 511-526, 18 figs. Based on study of microstructure, hardness, density, magnetic properties and thermal characteristics of a typical high speed steel.

STEEL MANUFACTURE

Direct Processes. Making Steel Direct from Ore. Iron Trade Rev., vol. 68, no. 20, May 19, 1921, pp. 1375-1376. Comparison of Basset and Jones processes. Basset process maintains higher temperature in furnace by introducing preheated air and carbon and chemical reactions differ to some extent.

New Method of Manufacturing Cast Iron and Steel in France, Paul H. Cram. U. S. Dept. of Commerce, Commerce Reports, no. 130, June 6, 1921, pp. 1330. It is stated that Basset Steel Works, after having concluded successful experiments in 100-ton furnace, will construct 12 Basset furnaces for direct manufacture of steel having total daily capacity of 3000 tons.

Steel Direct from Ore by Moffat Process, W. F. Sutherland. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1450-1452, 3 figs. Reduction in metallizer and conversion into steel in electric furnaces.

The Canadian Steel Industry and the Direct Process, Noel Statham. Iron & Steel of Canada, vol. 4, no. 4, May 1921, pp. 91-98, 3 figs. Bourcoud open-cycle direct process and its economical possibilities under present conditions of Canadian iron and steel industrial development. Process consists in reducing iron ore with gases at sufficiently high temperature, transferring reduced metal to electric furnace where it is melted, and subsequently to another electric furnace where it is finally refined.

Electric-Furnace. Electric Furnaces for Making Steel—IV, Alfred Stansfield. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 381-385, 6 figs. General features and advantages of Ludlum furnace and of Vom Baur furnace. Classification of electric steel-making furnaces.

Open-Hearth Practice. A Radical Change in Open-Hearth Practice, George L. Prentiss. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1479-1481, 7 figs. Making blow torch of ports in Egler furnace at plant of Brier Hill Steel Co., Youngstown, O. resulted in increased efficiency.

Processes. Manufacture of Steel from Raw Materials to Finished Product—Remarks on Heat Treatment and Fatigue Failures, W. R. Shimer. Trans. Am. Soc. for Steel Treating, vol. 1, no. 8, May 1921, pp. 423-435, 85 figs. Photomicrographs.

STEEL WORKS

Electric Drive. Steel Works Motors, W. W. Wood. Beama, vol. 8, no. 5, May 1921, pp. 440-444, 3 figs. Three-phase versus direct current. No definite rule is laid down, but three-phase motors are preferred.

England. British Iron and Steel Centers, Joseph Horton. Iron Trade Rev., vol. 68, nos. 20 and 23, May 19, and June 9, 1921, pp. 1388-1390 and 1392, 3 figs., and 1590-1592 and 1597-1598, 5 figs. May 19: Manufacture of pig iron and steel in Middlesborough District. June 9: Steel mills in Sheffield.

France. The Devastation of France. Engineering, vol. 111, no. 2892, June 3, 1921, pp. 670-674, 23 figs. partly on 4 supp. plates. Reconstruction of steel mills.

Fuel Economy. Heat Conservation in Steel Works Operation (Die Wärmewirtschaft im Eisenhüttenbetrieb), A. Schulze. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 19, May 7, 1921, pp. 487-491, 3 figs. Measures for low-temperature heat conservation are discussed and examples given to show how saving can be effected.

Pig-Casting Machine. Pig-Casting Machine and Iron Storage. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1384-1385, 2 figs. Equipment at Hamilton works of Steel Co. of Canada includes quenching pit and station for transferring iron between ladles.

Power Plants. Modern Steel Works Power Plants, Walter N. Flanagan. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1555-1559, 4 figs. Centralization and economy of unit stresses. Attention to details urged as source of savings. Paper presented before Am. Iron & Steel Inst.

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Chain-Grate. Recording Ash-Pit Loss from Chain Grate Stokers, E. G. Bailey. Mech. Eng., vol. 43, no. 6, June 1921, pp. 381-385, 12 figs. Recording device consists of thermometer bulb filled with nitrogen and connected through capillary tube to mercury U-tube, one leg of which is open to atmosphere and carries a float to which recorder pen is attached.

Draft Resistance. Draft Resistance of Underfeed Stokers, Alfred Cotton. Power, vol. 53, no. 22, May 31, 1921, pp. 874-875, 3 figs. Graphs constructed from results obtained in experiments.

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Strength. The Strength of Submarine Vessels, W. R. G. Whiting. Engineering, vol. 111, no. 2891, May 27, 1921, pp. 662-664, 12 figs. Diagrams and formulas for determining stresses developed in submerged submarine. Paper read before Instn. Naval Architects.

SUPERHEATED STEAM

Specific Heat. Specific Heat of Superheated Steam, M. T. Eichhorn. Power, vol. 53, no. 22, May 31, 1921, pp. 892, 1 fig. Nomograms of properties of superheated steam.

SWAGING

Cold Swaging. Cold Swaging—I, Fred R. Daniels. Machy (N. Y.), vol. 27, no. 10, June 1921, pp. 930-934, 8 figs. Also in Machy. (Lond.), June 2, 1921, pp. 257. Application of swaging process and its effect on quality of metal. Study based on experience of Torrington Co., Torrington, Conn.

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TABULATING MACHINES

Census Tabulating. Census Tabulating Machine. Engr., vol. 131, no. 3412, May 20, 1921, pp. 532-533 and 535, 3 figs. Hollerith patented machine.

TERMINALS, LOCOMOTIVE

Design. The Roundhouse Up to Date, Harold C. Prentice. Ry. Mech. Engr., vol. 95, no. 6, June 1921, pp. 337-340, 4 figs. Survey of developments in design of locomotive terminals.

TERMINALS, RAILWAY

Chicago. Proposed Improvement of Chicago Railway Terminals. Eng. News-Rec., vol. 86, no. 20, May 19, 1921, pp. 845-847, 2 figs. Report of Chicago Railway Terminal Commission.

TESTING MACHINES

Brinell. Brinell Testing Machine for Large Forgings. Engineering, vol. 111, no. 2892, June 3, 1921, pp. 680, 4 figs. Machines constructed for testing large forgings by W. & T. Avery, Birmingham, England.

Small-Ball Hardening. Small-Ball Hardening Testing Machine. Engineering, vol. 111, no. 2890, May 20, 1921, pp. 612, 4 figs. Machine employs balls of 1, 2 or 5 mm. in diameter and is intended for normal working with 1 mm. and 2 mm. sizes and deadweights up to 50 kg.

Torsion-Bending. Alternating Stress Testing Machine. Engr., vol. 131, no. 3412, May 20, 1921, pp. 550, 2 figs. Slow-speed machines giving 200 cycles of combined bending and torsion per minute.

TIME STUDY

Training. Training Toward True Time Standards, C. B. Tyson. Factory, vol. 26, no. 12, June 15, 1921, pp. 1402-1406, 5 figs. Course of study developed at New York Shipbuilding Corporation plant.

TOOLS

Oil-Well. Manufacturing Oil-Well Tools in Texas, Fred H. Colvin. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 932-938, 24 figs. Production systems of manufacturing bits, cutter, etc.

Press. The Design and Construction of Press Tools—IX. Eng. Production, vol. 2, no. 36, June 9, 1921, pp. 691-693, 4 figs. Drawing dies for cartridge cases.

TUBES

Seamless, Manufacture. Making Seamless Steel Tubes. Eng. Production, vol. 2, no. 35, June 2, 1921, pp. 675-679, 13 figs. Description of process involved.

TURBO-GENERATORS

Ventilation. Practice in Use of Electrical Apparatus. Elec. World, vol. 77, no. 23, June 4, 1921, pp. 1314-1316. Closed-circuit system of ventilating turbo-generators coming into favor. Tendency toward greater use of electrically driven auxiliaries. Data on oil-circuit-breaker performance. Committee report presented at conference of Nat. Elec. Light Assn.

TURBULENCE

Research. Turbulence, H. C. Horning. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 579-587, 13 figs. Collection of notes gathered from investigation of subject in literature of developments on internal-combustion engines and memoranda set down during long series of tests, also discussion of physical and chemical aspects of turbulence and methods of measuring it together with theory explaining it.

TYPEWRITERS

Accessories. Typewriter Inks and Ribbons. Sci. Am. Monthly, vol. 3, no. 6, June 1921, pp. 536-537. Review of some German methods of manufacture.

Manufacture. Milling Slender Castings, Franklin D. Jones. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 935-937, 5 figs. Fixtures used at Smith Premier Works of Remington Typewriter Co. for holding slender parts without springing.

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VENTURI METERS

Accuracy. A New Hydraulic Paradox. Engineering, vol. 111, no. 2891, May 27, 1921, pp. 639-640. Relative velocities at metering inlet and at throat.

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WAGES

Piece-Time System. Compensation Piece-Time System (Das Ausgleich-Stückzeit Verfahren), Adolf Lauffer. Betrieb, vol. 3, no. 16, May 10, 1921, pp. 484-492, 6 figs. Wage method taking into consideration possibility of shortening individual working periods.

WASTE RECLAMATION

Railway Shops. Saving Materials in Railroad Shops, Frank A. Stanley. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 943-944, 7 figs. Methods of recovering lining metal from worn car journal bearings, also old bolts and air hose.

[See also BONUS SYSTEMS.]

Railways. Reclamation a By-Product of the Railway Business, R. K. Graham. Ry. Rev., vol. 68, no. 23, June 4, 1921, pp. 843-848, 10 figs. Origin and development of centralized reclamation on Atchison Topeka & Santa Fe Ry.

WATER POWER

California. The Marshall Plan for Utilizing California's Waters. Eng. News-Rec., vol. 86, no. 23, June 9, 1921, pp. 994-996. Program for utilizing in California valley all important streams of state for irrigation, power and domestic uses.

Canada. Relation of Water Power to the Fuel Problem. Can. Engr., vol. 40, no. 21, May 26, 1921, pp. 503-506 and 510, 4 figs. Per capita coal consumption in Canada 50 per cent less than in U. S. and water power development 194 per cent greater. Developments reduce annual coal bill $146,500,000.

Legislation in United States. Analysis of the Water Power Act, Henry King Love. Water Power, vol. 3, no. 4, May 1921, pp. 11-14. How it proposes to protect consumers and reward investors and developers. Government financing, it is claimed, would be desirable and proper to effect speedy utilization of waste.

WATER PURIFICATION

Army Field Processes. Chemical Purification Processes for the Water Supply of Troops in the Field (Die chemischen Reinigungsverfahren bei der Wasserversorgung der Truppe im Felde), A. Heilmann. Gesundheits-Ingenieur, vol. 44, nos. 18 and 20, Apr. 30 and May 14, 1921, pp. 213-215 and 236-237. Notes on various German and French sterilizing processes successfully used during war.

WELDING

Preheating. Preheating Practice, David Baxter. Acetylene Jl., vol. 22, no. 12, June 1921, pp. 655-658, 5 figs. Preheating said to be a fundamental to successful welding procedure. Several examples are given.

Steel. The Welding of Steel in Relation to the Occurrence of Pipe, Blowholes, and Segregates in Ingots, H. Brearley. Iron & Steel Inst., annual meeting, May 5-6, 1921, advance paper no. 2, 17 pp. 12 figs. Microscopical examinations.

[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; ELECTRIC WELDING, RESISTANCE.]

WELDS

Testing. Standards for Testing Welds. Welding Engr., vol. 6, no. 5, May 1921, pp. 28-29, 32, 34 and 36, 14 figs. Also in Acetylene Jl., June 1921, pp. 661, and Ry. Elec. Engr., June 1921, pp. 237. Report to the Bur. of Welding, of Committee on Standard Tests for Welds. Specifications are intended primarily to serve as a standard, uniform basis testing and comparing sample welds as distinguished from welds in structures.